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ORIGINAL PAGE
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CONTRACT NAS8-33300

mps

MATERIALS PROCESSING IN SPACE/SPACELAB.
FES/VCGS PAYLOAD CRITICAL DESIGN REVIEW (TRW
Systems Group) 173 p HC AC8/MF A01 CSCL 22A

N82-19235

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G3/12

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MATERIALS PROCESSING IN SPACE/SPACELAB

FES/VCGS PAYLOAD
CRITICAL DESIGN REVIEW

25 SEPTEMBER 1980



MPS/SL FES/VDGS CDR
GENERAL PRESENTATION

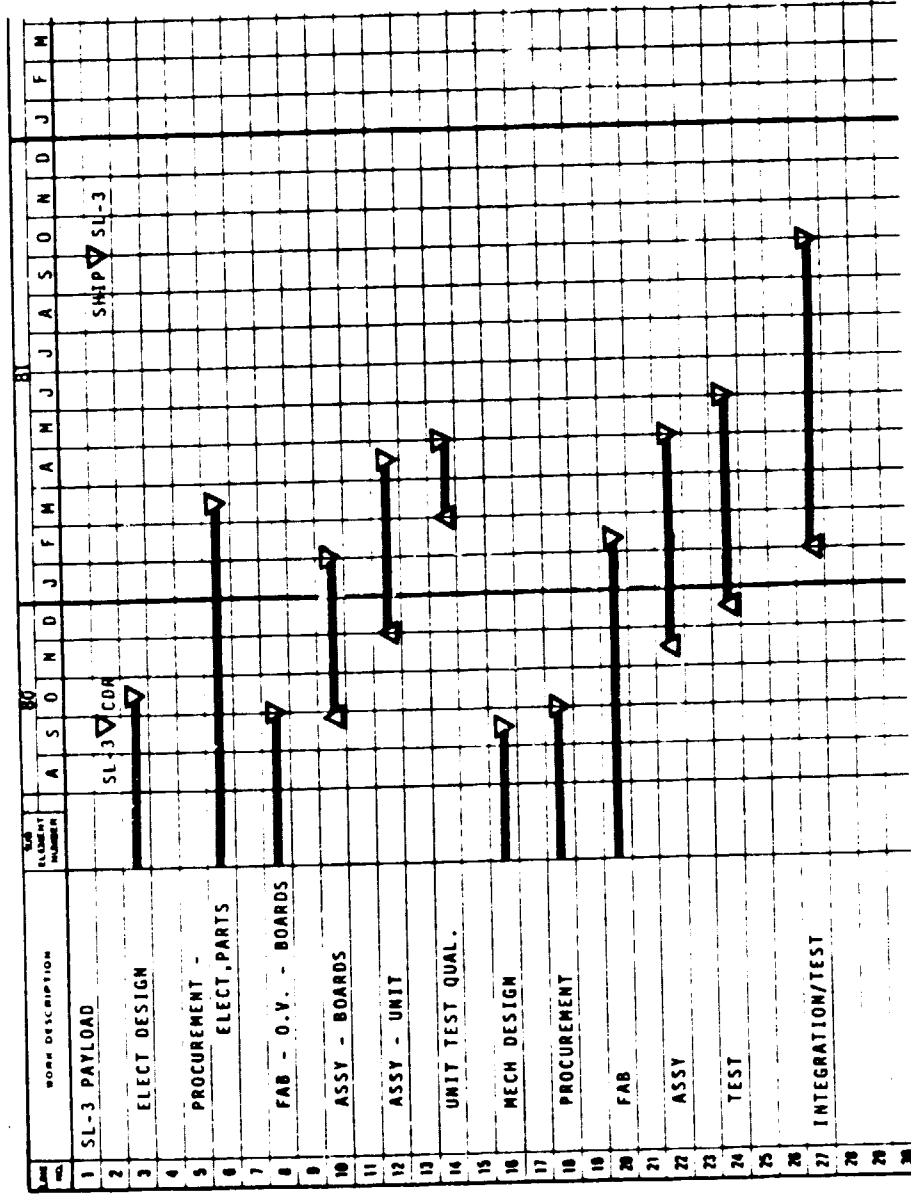
AGENDA

<u>TIME</u>	<u>TOPIC</u>	<u>SPEAKER</u>
8:30	0 INTRODUCTORY COMMENTS	W. R. ADAMS
	0 TECHNICAL PRESENTATION BY TRW	
8:40	- INTRODUCTION	N. BARTER
8:45	- PDR SYNOPSIS	J. McCURRY
9:15	- POST-PDR ACTIONS	J. McCURRY
	- CURRENT DESIGN STATUS	
9:40	o DESIGN APPROACH	J. McCURRY
	o CURRENT DESIGN	
9:45	-- FLUID EXPERIMENT SYSTEM	J. FLANNERY
11:00	-- VAPOR CRYSTAL GROWTH SYSTEM	M. COTTIS
12:00	LUNCH	
1:00	o PRODUCT ASSURANCE	V. SIVILLI
1:30	o VERIFICATION	J. McCURRY
1:50	o SYSTEM LEVEL SYNOPSIS	J. McCURRY
2:10	o GROUND SUPPORT EQUIPMENT	J. McCURRY
2:25	o OPERATIONS PLANNING	J. McCURRY
2:35	- CDR STATUS SUMMARY	J. McCURRY
2:45	0 MSFC RID & SAR SUMMARIES, & MAJOR CONCERNS	TEAM CHAIRPERSONS
4:15	0 SUMMARY REMARKS	W. R. ADAMS

AGENDA (CONTINUED)

<u>TIME</u>	<u>TOPIC</u>	<u>TEAM NO.</u>	<u>SPEAKER</u>
2:45-2:55	INTRODUCTION	N/A	VAUGHN YOST
2:55-3:05	SYSTEMS ENGINEERING, ETC., TEAM	1	ART BOESE
3:05-3:15	MECHANICAL DESIGN & DEVELOPMENT TEAM	2	JOE CARLTON
3:15-3:25	ELECTRICAL DESIGN & DEVELOPMENT TEAM	3	JOE BURSON
3:25-3:35	ASSEMBLY & VERIFICATION TEAM	4	BOB RIEMER AND/ OR BILL BOWEN
3:35-3:45	SOFTWARE TEAM	5	STEVE TONDERA
3:45-3:55	SCIENCE TEAM	6	BARBARA ASKINS
3:55-4:05	SUMMARY OF ALL TEAMS RID'S & SAR'S	N/A	VAUGHN YOST
4:05-4:15	SCHFDULE FOR PREBOARD AND BOARD MEETINGS	N/A	VAUGHN YOST

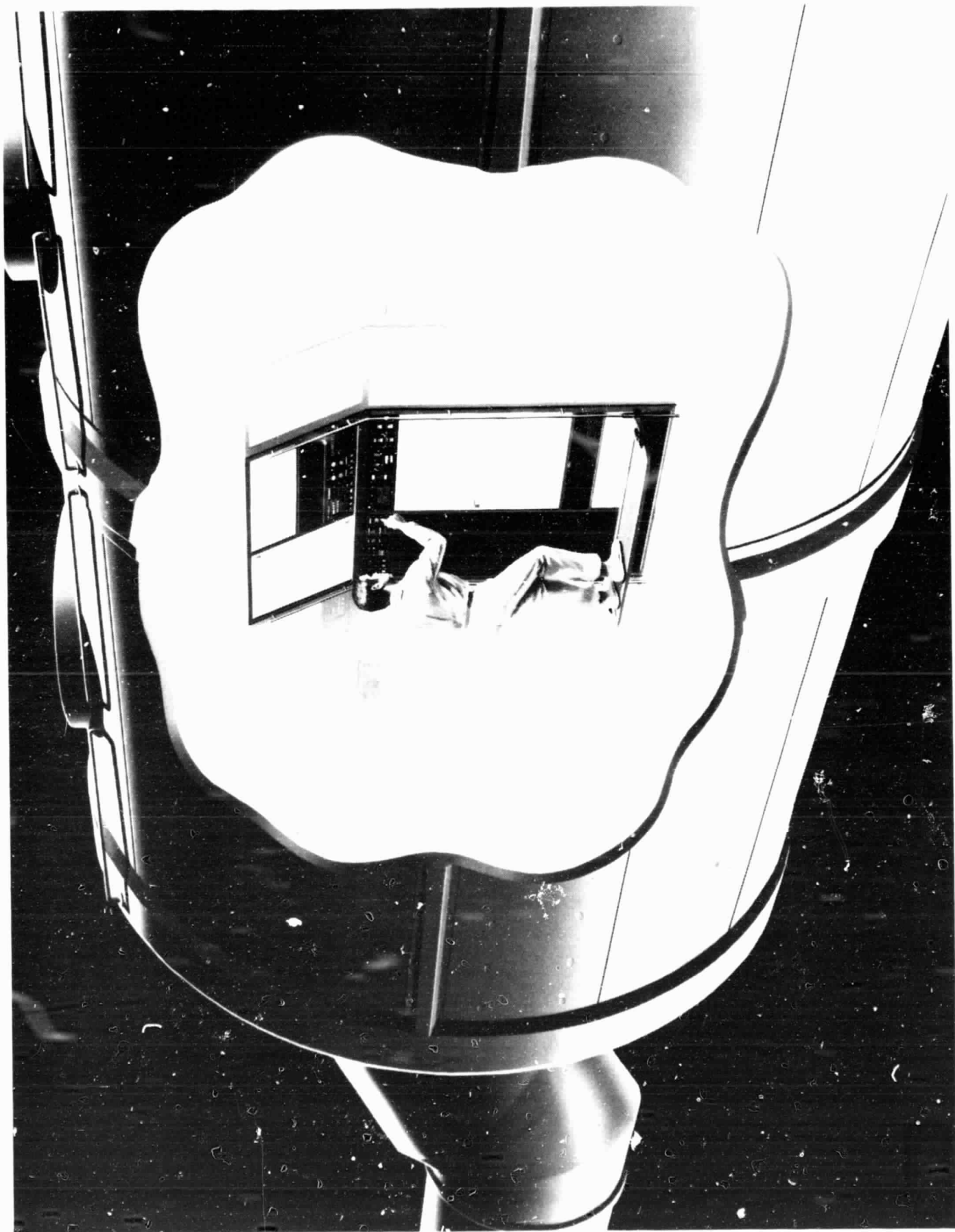
SL-3 PAYLOAD MILESTONE SCHEDULE



TRW/ASFO

SL-3 MPS PDR SYNOPSIS

- PRELIMINARY DESIGN SUMMARY
 - FES
 - VCGS
- POST-PDR ACTION/SCHEDULE ACTIVITIES



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SL-3 PRELIMINARY DESIGN SUMMARY

- FLUIDS EXPERIMENT SYSTEM (FES)
 - RADIAL GROWTH TEST CELL
 - OPTICAL BENCH WITH HOLOGRAPHY
 - TV MONITOR
 - SEMI-AUTOMATIC CONTROL
 - OPERATOR CONTROL PANEL
 - PRE-HEAT ENCLOSURE
 - STORAGE ENCLOSURE
 - SPACELAB DOUBLE RACK



SL-3 PRELIMINARY DESIGN SUMMARY

- VAPOR CRYSTAL GROWTH SYSTEM (VCGS)
 - FURNACE/AMPOULE (FLT VERSION OF PIs)
 - EXPERIMENT ENCLOSURE
 - MICROSCOPE VIEWING
 - TV MONITOR (FES SHARED)
 - SEMI-AUTOMATIC CONTROL (FES SHARED)
 - OPERATOR CONTROL PANEL (DEDICATED & FES SHARED)
 - STORAGE ENCLOSURE
 - SPACELAB SINGLE RACK (NEXT TO FES)



POST-PDR ACTION/SCHEDULE ACTIVITIES

- PDR RID AND ACTION ITEM STATUS
- SIGNIFICANT PDR CONCERNS AND SUBSEQUENT ACTIONS
- POST-PDR ACTIVITIES
 - SCHEDULE
- DESIGN
- PROCUREMENT AND FAB
- TESTING



PDR RID AND ACTION ITEM STATUS

- FROM DATA PACKAGE REVIEW AND PRESENTATION
 - 20 ACTION ITEMS
 - 192 RIDS ADDRESSED
- ALL ACTION ITEMS COMPLETED
- ALL BUT FIVE RIDS COMPLETED
 - MATERIALS ACTIONS
 - COMPLETED BY 30 OCTOBER 80



SIGNIFICANT PDR CONCERNS AND SUBSEQUENT ACTIONS

- FES
- CONCERN - THROTTLING VALVE IN MPE WATER LOOP
 - ACTION - REMOVED VALVE
- CONCERN - COPPER HEAT EXCHANGER MATERIAL
 - ACTION - SPACELAB APPROVED COPPER
- CONCERN - TOXICITY OF FC-43 FLUID LOOP LIQUID
 - ACTION - CHANGED TO WATER
- CONCERN - USE OF SWAGELOK FITTINGS ON FLUID LINES
 - ACTION - CHANGED TO FLARED FITTINGS WITH VOISHAN WASHERS
- CONCERN - HOLOGRAM INTERFERENCE FROM WINDOW BOWING AND AIR FLOW AROUND CELL
 - ACTION - BREADBOARD TESTS PROVED NO PROBLEM



SIGNIFICANT PDR CONCERNS - (CONT'D)

- VCGS
 - CONCERN - VCG STING SETPOINT TEMPERATURE NOT ADJUSTABLE
 - ACTION - MADE VALUE ADJUSTABLE
 - CONCERN - VCG DRAWER DID NOT HAVE EMERGENCY EGRESS QUICK LATCHES
 - ACTION - ADDED QUICK LATCHES
 - CONCERN - ON-ORBIT VIBRATION OF VCG RACK FROM FES CELL STORAGE
 - ACTION - PREVENT WITH ON-ORBIT STOWAGE PROCEDURE



SIGNIFICANT PDR CONCERNS - (CONT'D)

● FES AND VCGS

- CONCERN - SPACELAB SUPPLY VOLTAGE FROM EPSP BELOW SPEC MINIMUM
 - ACTION - SPACELAB MIN VOLTAGE FROM EPSP WILL BE NO LOWER THAN 24 VOLTS
- CONCERN - USE OF POLYALKENE INSULATION ON WIRE
 - ACTION - POLYALKENE WILL NOT BE USED
- CONCERN - ALL TIMELINE EXPERIMENT PARAMETERS NOT ADJUSTABLE
 - ACTION - ALL TIMELINE PARAMETERS NOW ADJUSTABLE
- CONCERN - TOO EARLY COMMITMENT DATE FOR FLIGHT SOFTWARE FROM EXPERIMENT VALUES STANDPOINT
 - ACTION - ADDED BREADBOARD (ADJUSTABLE) MEMORY MODULE FOR GCEL PCDA AND SECOND PRODUCTION MEMORY MODULE (LATER DELIVERY) FOR FLIGHT



POST-PDR ACTIVITIES SCHEDULE

ACTIVITY	1980											
	1979	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
PDR	◀											
BREADBOARD TESTING												
DETAILED DESIGN												
ELECTRONIC CIRCUIT												
ELECTRONIC PRODUCT												
MECHANICAL												
SOFTWARE												
TRW UNIT DESIGN REVIEWS												
CDR DATA PACKAGE												
CDR												



TRW/ASPO

CURRENT ACTIVITIES STATUS

● FES DESIGN OVERVIEW	JOHN FLANNERY
● VCGS DESIGN OVERVIEW	MILT COTTIS
● PRODUCT ASSURANCE OVERVIEW	VINCE SIVILLI
● VERIFICATION OVERVIEW	JIM MCCURRY
● SYSTEM LEVEL SYNOPSIS	JIM MCCURRY
● OPERATIONS PLANNING STATUS	JIM MCCURRY
● GROUND SUPPORT EQUIPMENT OVERVIEW	JIM MCCURRY
● CDR STATUS SUMMARY	JIM MCCURRY



DESIGN PRESENTATION CONTENT

- FES AND VCGS OVERVIEW
 - DESIGN SUMMARY BY MODULE
- PRODUCT ASSURANCE OVERVIEW
 - RELIABILITY
 - MATERIALS
 - SAFETY
- VERIFICATION OVERVIEW
 - SCHEDULE
 - BREADBOARD TESTS
 - DEVELOPMENT TESTS
 - UNIT QUAL TESTS
 - VERIFICATION BY SIMILARITY
 - SYSTEM QUAL/ACCEPTANCE
 - LEVEL IV/III/II/I
- SYSTEM LEVEL SYNOPSIS
 - MASS
 - POWER
 - THERMAL
 - MISSION PLANNING



DESIGN PRESENTATION CONTENT (CONT'D)

- GROUND SUPPORT EQUIPMENT OVERVIEW
 - MGSE LIST AND FUNCTION
 - EGSE LIST AND FUNCTION
- OPERATIONS PLANNING STATUS
 - INTEGRATION DESIGN
 - INTEGRATION OPERATIONS



FLUIDS EXPERIMENTS SYSTEM

CDR DESIGN OVERVIEW



FLUIDS EXPERIMENTS SYSTEM

CDR DESIGN OVERVIEW



FES EXPERIMENT OVERVIEW

- EXPERIMENT
 - SOLUTION GROWTH OF CRYSTALS IN LOW GRAVITY ENVIRONMENT
- PRINCIPAL INVESTIGATOR
 - R. B. LAL, ALABAMA A&M UNIVERSITY
- CO-PRINCIPAL INVESTIGATOR
 - R. L. KROES, MARSHALL SPACE FLIGHT CENTER
- SCIENCE OBJECTIVE
 - STUDY SOLUTION GROWTH OF CRYSTALS OF TRIGLYCINE SULFATE IN LOW GRAVITY
 - OBSERVE HEAT AND MASS TRANSPORT DURING CRYSTAL GROWTH
- EXPERIMENT MODULE
 - THREE RADIAL GROWTH TEST CELLS



TRW/ASPO

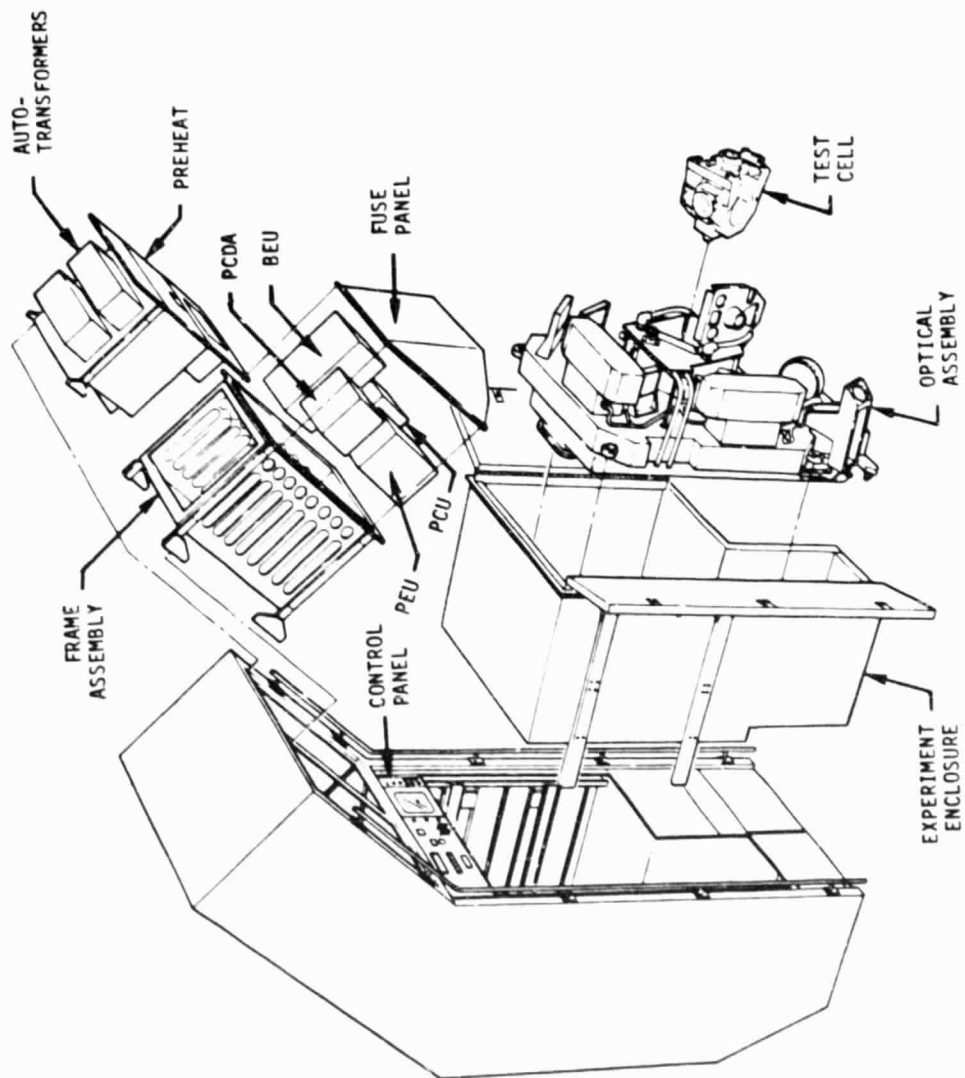
FLUIDS EXPERIMENT'S SYSTEM PRESENTATION

1. HARDWARE IDENTIFICATION
2. EXPERIMENT MODULE
3. SUPPORT MODULE
4. STORAGE ENCLOSURES
5. SYSTEM REQUIREMENTS VS CAPABILITIES



TRW/ASPO

FES SUPPORT MODULE AND EXPERIMENT MODULE



TRW/ASPO

FES SYSTEM UNIT FUNCTIONS

EXPERIMENT MODULE/TEST CELL

- ENCLOSURES THE SEED CRYSTAL AND TGS FLUID
- PROVIDES THE PROPER THERMAL ENVIRONMENT FOR CRYSTAL GROWTH

OPTICAL ASSEMBLY

- RECORDS THE CRYSTAL GROWTH PROCESS ON FILM, UTILIZING HOLOGRAPHIC METHODS
- TV CAMERAS VIEW THE CRYSTAL FOR A REAL TIME PICTURE OF THE CRYSTAL

EXPERIMENT ENCLOSURE

- PROVIDES A LIGHT TIGHT ENCLOSURE FOR THE OPTICS
- INCLUDES AIR CONDITIONING AND FLUID LOOP HARDWARE

PREHEAT ENCLOSURE

- ENCLOSURES THE TEST CELL DURING PREHEAT OF TGS FLUID

STORAGE ENCLOSURE

- ENCLOSURES THE TEST CELLS WHEN NOT IN PREHEAT OR IN THE OPTICAL ASSEMBLY



TRW/ASPO

EES SYSTEM UNIT FUNCTIONS

PCDA

- AUTOMATICALLY SEQUENCES AND CONTROLS ALL THERMAL OPERATIONS, MECHANICAL OPERATIONS, AND DATA TRANSFERS

ACCELEROMETER

- SENSES THREE-AXIS ACCELERATION LEVELS ON THE OPTICAL ASSEMBLY

OPERATOR CONTROL PANEL

- ACCESSES AND DISPLAYS DATA FROM PCDA AND TV CAMERAS
- PROVIDES MEANS FOR MANUALLY CHANGING PARAMETER VALUES

CELL ELECTRONICS UNIT

- PROCESSES CELL TEMPERATURE DATA AND DRIVES CELL HEATERS

BENCH ELECTRONICS UNIT

- DRIVES MECHANISMS ON OPTICAL ASSEMBLY

PREHEAT ELECTRONICS UNIT

- PROCESSES CELL SENSOR AND HEATER SIGNALS DURING PREHEAT OPERATION

POWER CONDITIONING UNIT

- SUPPLIES CONDITIONED POWER TO UNITS



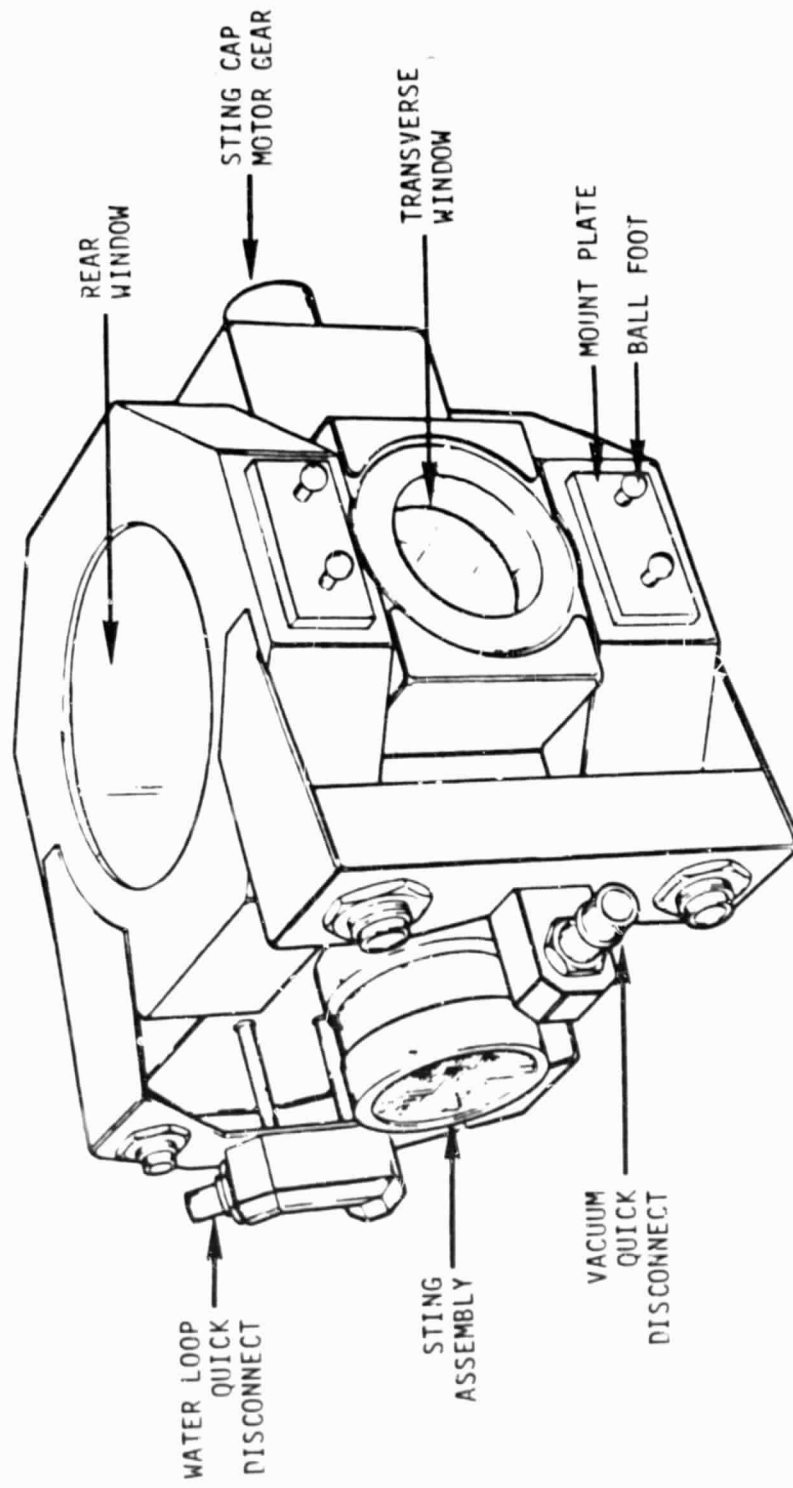
TRW/ASPO

FES EXPERIMENT MODULE



TRW/ASPO

FES EXPERIMENT MODULE



TRW/ASPO

FES TEST CELL FEATURES

DOUBLE WALL CONSTRUCTION TO MINIMIZE EFFECTS OF EXTERNAL DISTURBANCES

- HEATERS AND SENSORS ON OUTER WALL
- GOLD COATED NICKEL INNER WALL

DOUBLE PANE WINDOWS

- SCHLIEREN QUALITY FORWARD AND AFT WINDOWS
- TRANSPARENT HEATER COATINGS

STING ASSEMBLY

- POSITIONS CRYSTAL NEAR CENTER OF CELL
- STING TIP TEMPERATURE CONTROLLED
- FINS AND HEAT PIPE TRANSFER HEAT TO AIR SUPPLY

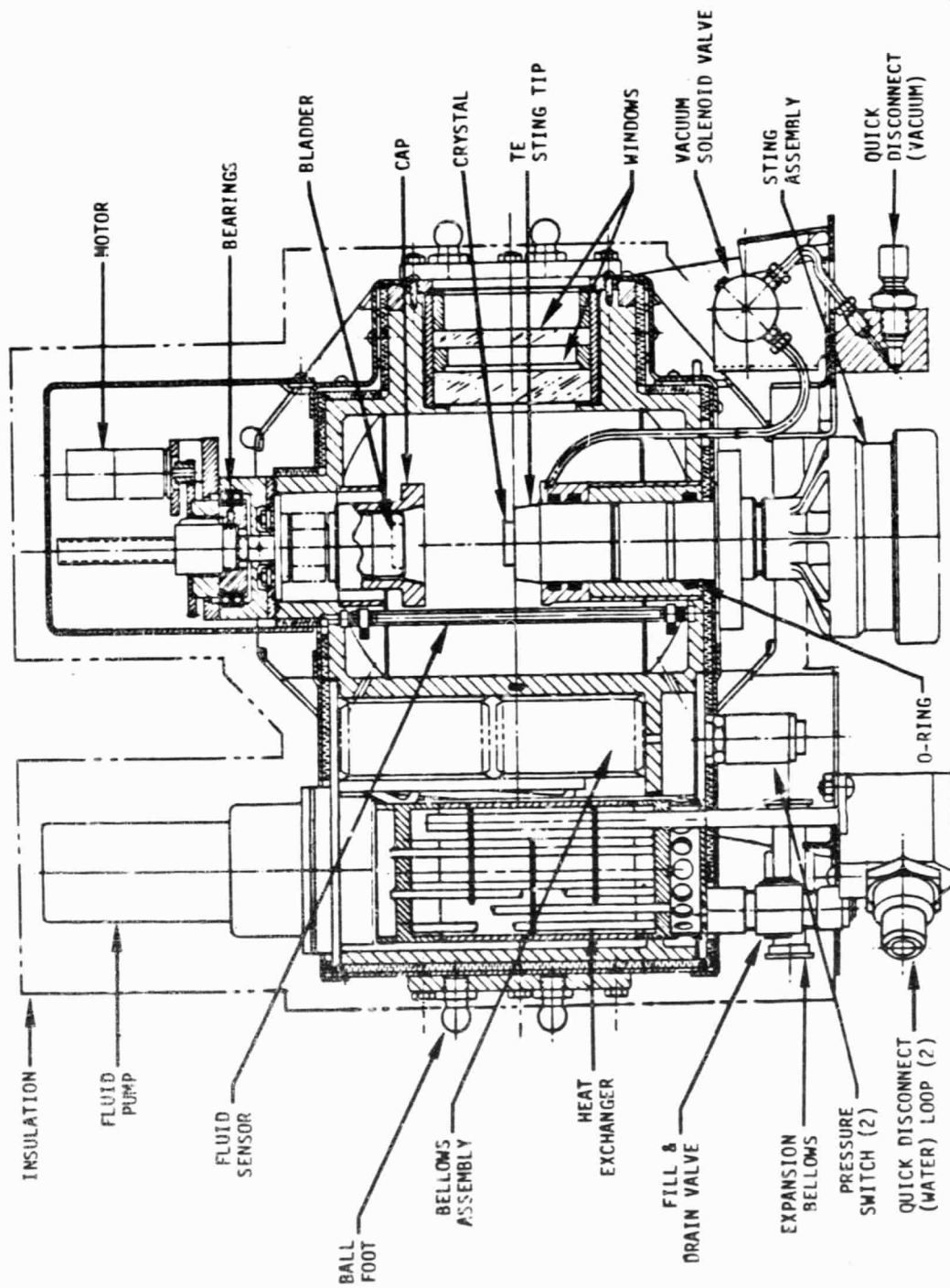
AUXILIARY COMPONENTS

- RETRACTABLE CAP
- STIRRER PUMP
- H₂O/TGS HEAT EXCHANGER
- INNER WALL AND FLUID TEMPERATURE SENSOR
- EXPANSION BELLOWES



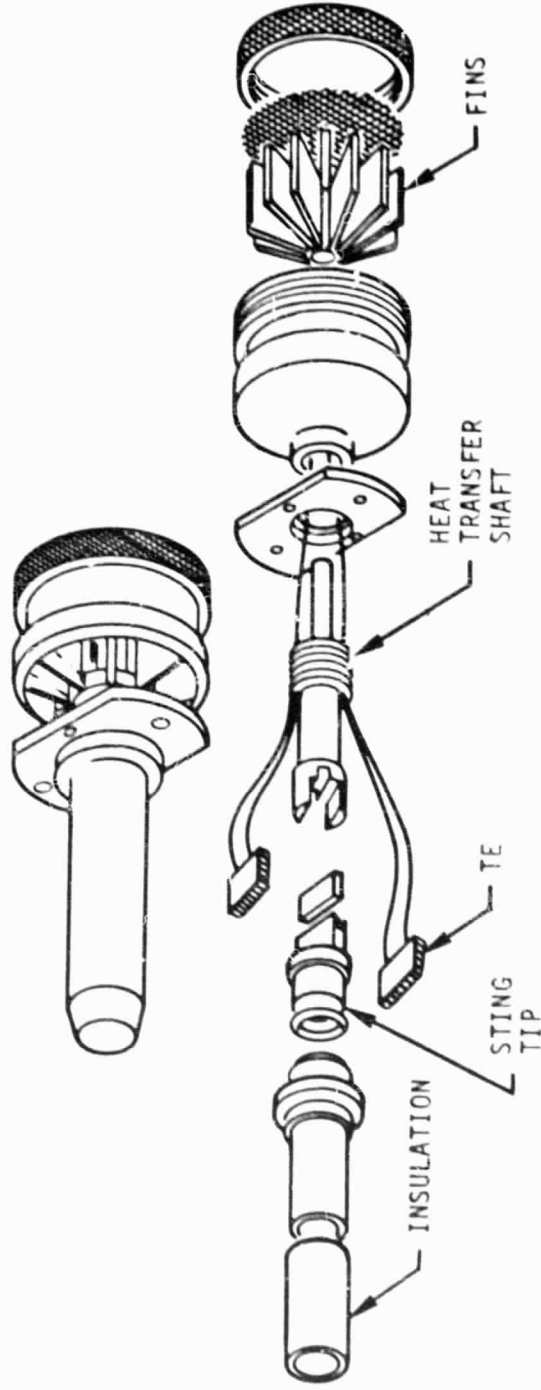
TRW/ASPO

FES TEST CELL



TRW/ASPO

FES STING ASSEMBLY



FES TEST CELL KEY REQUIREMENTS

PERFORMANCE PARAMETERS

CEI REQUIREMENT

● WALL TEMPERATURE	-	UNIFORMITY	0.1°C
	-	STABILITY	0.1°C
	-	REPEATABILITY	0.1°C
	-	ACCURACY	0.1°C
● STING TEMPERATURE	-	STABILITY	0.01°C
	-	ACCURACY	0.1°C
	-	CHANGE RATE	< 2°C/MIN.
● BUBBLE	-	VOLUME	TBD
● CRYSTAL ENVIRONMENT (PRE-EXPERIMENT)	-	TEMPERATURE	< 45°C
	-	MEDIA IN CONTACT	INERT GAS
● CRYSTAL ENVIRONMENT (POST-EXPERIMENT)	-	TEMPERATURE	< 45°C
	-	MEDIA IN CONTACT	< 2cc TGS



FES TEST CELL CAPABILITY

<u>CAPABILITY</u>	<u>BASIS</u>		<u>DESIGN</u>
	<u>B/B TEST</u>	<u>ANALYSIS</u>	
0.1°C	X	X	
0.01°C	X	X	
0.05°C	X	X	
0.06°C		X	
0.008°C		X	
0.05°C		X	
1.9°C/MIN		X	
7 MM ³	OCTOBER	X	
<45°C			X
ZENON			X
<45°C			X
1.8 cc TGS	IN PROCESS	X	

FES TEST CELL BREADBOARD TESTING

THERMAL TESTS

- OUTER WALL/INNER WALL STATIC OFFSET
- INNER WALL UNIFORMITY WITHIN $\pm 0.1^\circ$
- WINDOW UNIFORMITY NOT WITHIN $\pm 0.1^\circ$
 - WILL REPEAT WITH COATED WINDOW
 - DESIGN CHANGE ON RIM HEATER

BLADDER TESTS (IN PROCESS)

- TEST FPS AND ELASTOMER BLADDERS
- TEST FOR PERMEABILITY
- TEST FOR TRAPPED VOLUME $< 2\text{cc}$

BUBBLE TESTS (OCTOBER)

- RESIDUAL AIR IN CAP $< 7\text{mm}^3$
- METAL/TGS CHEMICAL REACTION
- LEAKAGE AROUND SEALS



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FES SUPPORT MODULE MECHANICAL ASSEMBLIES

1. OPTICAL ASSEMBLY
2. EXPERIMENT ENCLOSURE
3. PREHEAT ENCLOSURE



FES OPTICAL ASSEMBLY FEATURES

HOLOGRAPHY

- RUGGEDIZED HELIUM-NEON LASER FOR ILLUMINATION
- SIMPLE OPTICAL SYSTEM CONSISTING OF COLLIMATION OPTICS, BEAMSPLITTERS AND MIRRORS
- FILM TRANSPORTS FOR RECORDING HOLOGRAMS ON 70MM ROLL FILM

SCHLIEREN

- SIMPLE OPTICAL SYSTEM CONSISTING OF CONVERGING OPTICS, MIRRORS AND KNIFE EDGE
- VIDICON TV CAMERA SENSITIVE TO H₂NE LIGHT

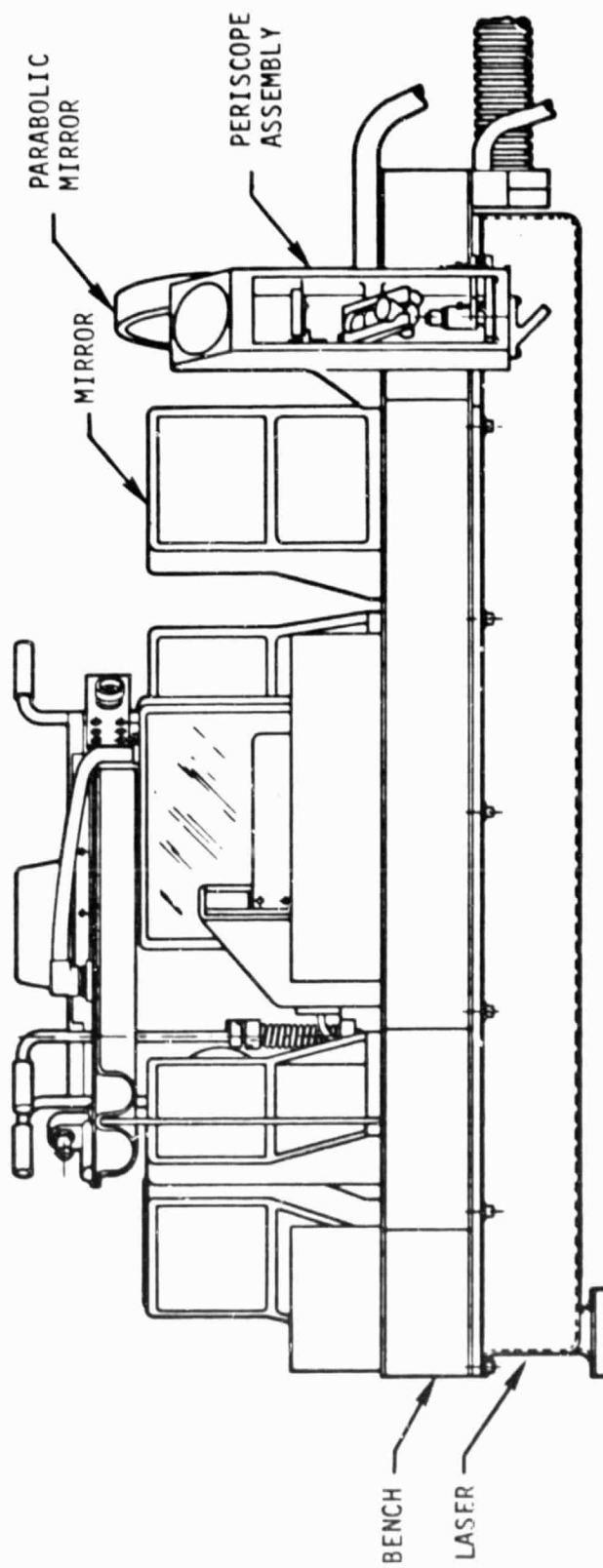
CONSTRUCTION

- HONEYCOMB BENCH WITH SUPER INVAR FACESHEETS
- OPTICS MOUNTS WITH NATURAL FREQUENCY >50 HZ
- FIBERGLASS AIR DUCTS



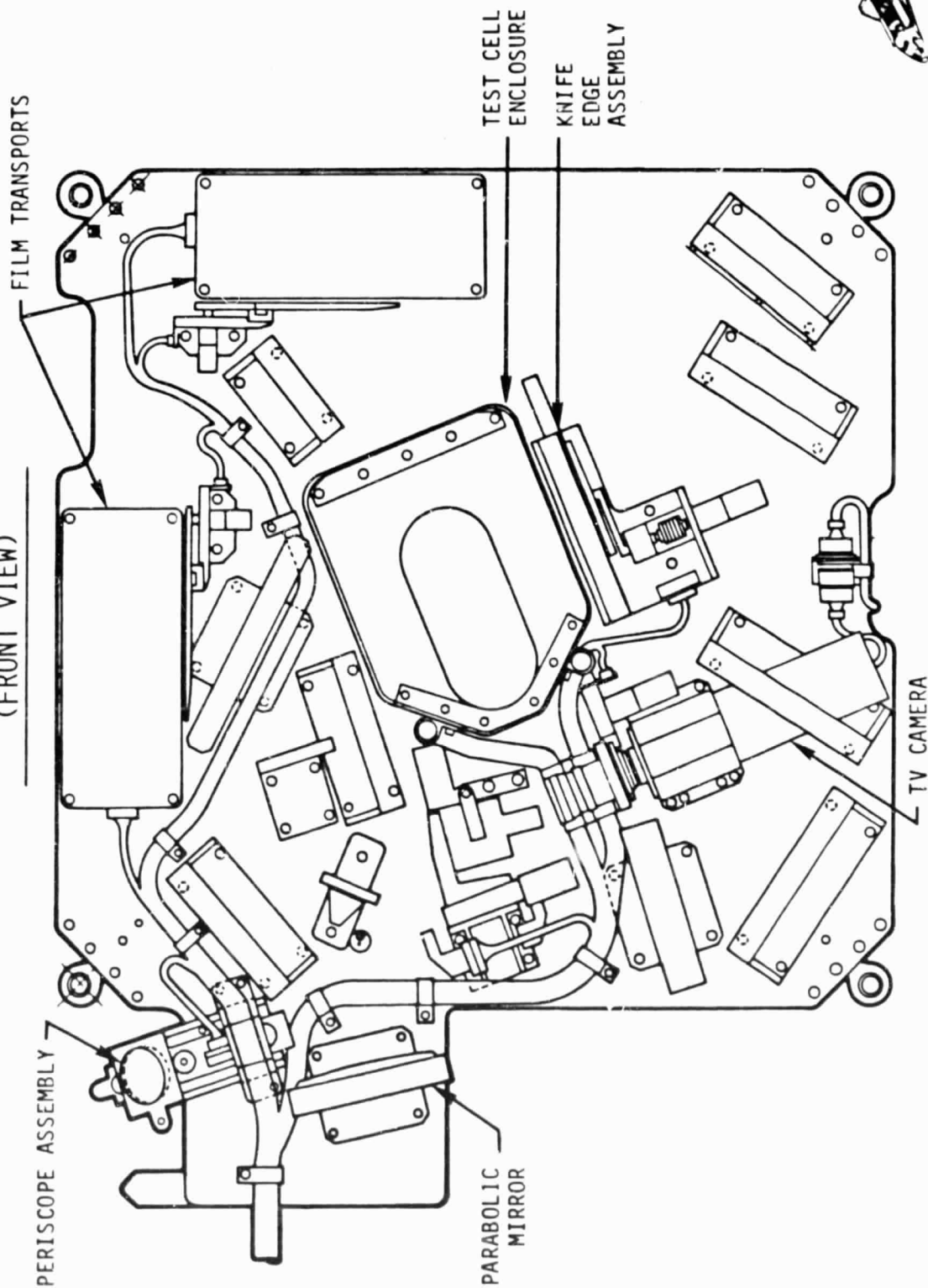
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FES OPTICAL ASSEMBLY
(SIDE VIEW)



TRW/ASPO

FES OPTICAL ASSEMBLY
(FRONT VIEW)



TRW/ASPO

FES OPTICAL ASSEMBLY REQUIREMENTS

<u>PARAMETER</u>	<u>KEY REQUIREMENTS</u>
PRIMARY VIEW	
BOUNDARY DIMENSIONS	
RESOLUTION	20 MICRONS
FIELD-OF-VIEW	2 CM X 2 CM X 2 CM
RADIANCE RATIO	5:1
TRANSVERSE VIEW	
BOUNDARY DIMENSIONS	
RESOLUTION	35 MICRONS
FIELD-OF-VIEW	2 CM X 2 CM X 2 CM
RADIANCE RATIO	TBD*
ELEMENT RESOLUTION	35 MICRONS
FIELD-OF-VIEW	2 CM X 2 CM X 2 CM
RADIANCE RATIO	TBD*
INDEX OF REFRACTION	
INDEX RESOLUTION	2×10^{-5}
GRADIENT (NORMAL TO OPTICAL PATH)	$5 \times 10^{-4} / \text{MM}^2$
FIELD-OF-VIEW	7 XT X 10 CM
FLOW VISUALIZATION	
GRADIENT RANGE	$8 \times 10^{-7} / \text{MM}^2$ TO $4 \times 10^{-5} / \text{MM}^2$
FIELD-OF-VIEW	10 CM X 10 CM



FES OPTICAL ASSEMBLY CAPABILITY

<u>CAPABILITY</u>	<u>B/B TEST</u>	<u>BASIS ANALYSIS</u>	<u>DESIGN</u>
15 MICRONS	X	X	
2 CM X 2 CM X 2 CM	X		X
5:1	X		
33 MICRONS	X	X	
2 CM X 2 CM X 2 CM	X		X
10 ⁵ :1	X	X	
33 MICRONS	X	X	
2 CM X 2 CM X 2 CM	X		X
10 ⁻⁵ :1	X	X	
1 X 10 ⁻⁵	X	X	
5 X 10 ⁻⁴ /MM	X	X	
7 CM X 10 CM			X
8 X 10 ⁻⁷ /MM TO 4 X 10 ⁻⁵ /MM	X	X	
10 CM X 10 CM			X



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FES OPTICAL ASSEMBLY BREADBOARD TESTING

OPTICAL PERFORMANCE

- UTILIZED THE PROPER GEOMETRY AND EXPOSURES
- INCLUDED DISTURBANCES DUE TO AIR FLOW, WINDOW BOWING, DELAYED FILM PROCESSING, AND WALL REFLECTIONS
- VERIFIED 20 MICRON RESOLUTION (PRIMARY AXIS)
- VERIFIED 35 MICRON RESOLUTION (TRANSVERSE AXIS)

MECHANISM PERFORMANCE

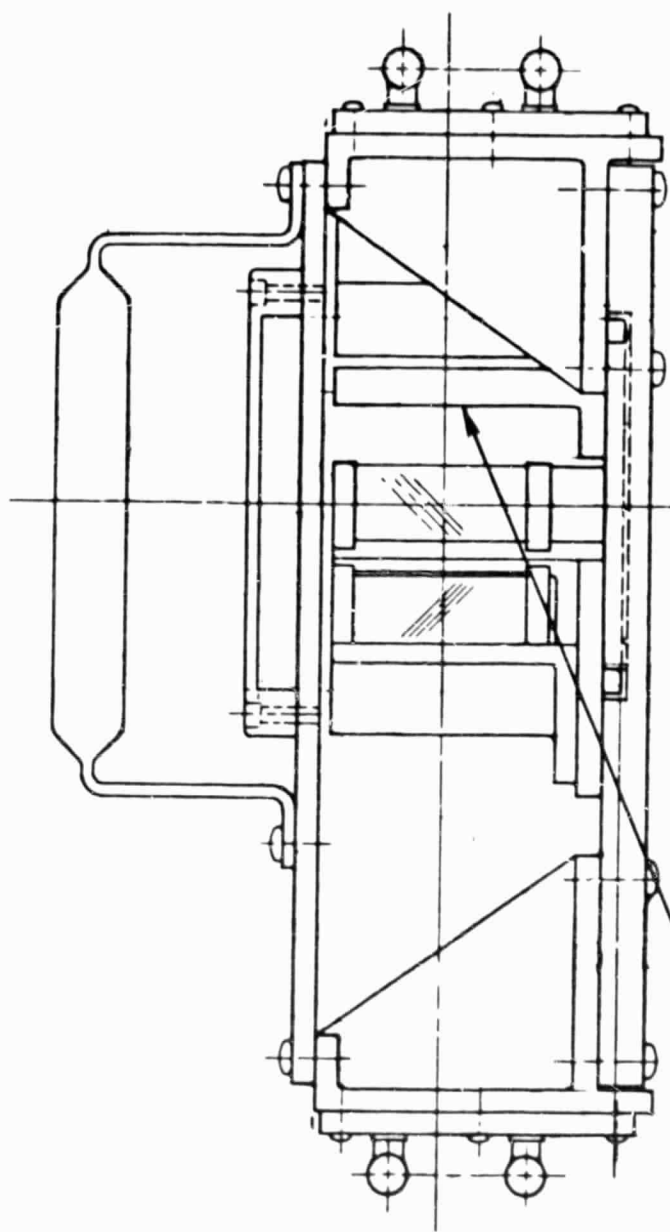
- FILM TRANSPORT TESTED, SHOWING COMPARABLE RESOLUTION
- KNIFE EDGE MECHANISMS TESTED, VERIFYING STEP RESOLUTION
- FOCUS MECHANISM TESTED
- SHUTTER MECHANISM TESTED

COMPONENT INTEGRITY

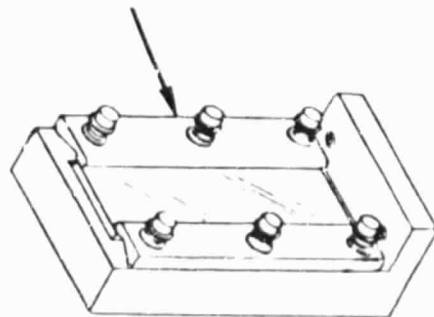
- VIBRATION TESTING OF LASER
- PULL TESTS OF HONEYCOMB BENCH



CALIBRATION CELL



TRANSVERSE TARGET ASSEMBLY
DIFFUSER
ND FILTERS
USAF 1951 TARGET



CALIBRATION CELL REQUIREMENTS

<u>PARAMETER</u>	<u>REQUIREMENTS</u>
FUNCTION	MEANS FOR FES ALIGNMENT AND CALIBRATION
REFERENCE TARGETS	NEUTRAL DENSITY FILTERS WEDGES INDEX OF REFRACTION GRADIENTS RESOLUTION CHARTS



TRW/ASPO

CAPABILITY

MEANS FOR FES ALIGNMENT AND CALIBRATION

ND FILTERS - 0, .5, 1, 1.5, 2, 2.5 FOR PRIMARY
AND TRANSVERSE

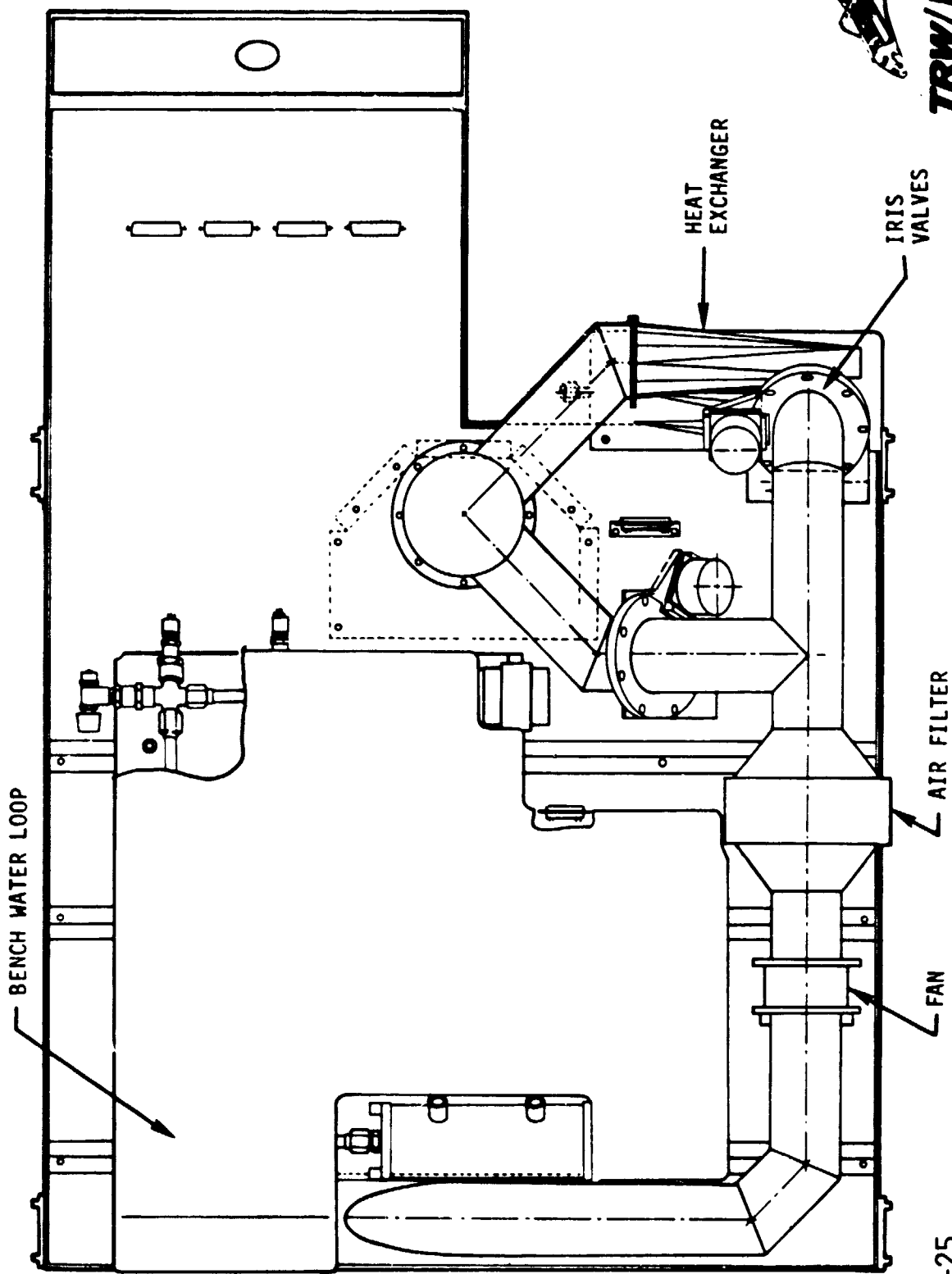
WEDGES FOR SCHLIEREN - .008, 3.6, 4.0 MILLIRADIANS

WEDGES FOR REFRACTIVE INDEX - 36.3 MICRON FRINGE SPACING

USAF 1951 RESOLUTION TARGET - 2 μ PER LINE TO 500 μ /LINE
FOR PRIMARY AND TRANSVERSE



FES EXPERIMENT ENCLOSURE



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FES EXPERIMENT ENCLOSURE FEATURES

ENCLOSURE

- ENCLOSURES OPTICAL ASSEMBLY
- SUPPORTS THE BENCH AIR SYSTEM
- SUPPORTS THE BENCH FLUID LOOP SYSTEM

BENCH AIR SYSTEM

- FILTERS AIR TO OPTICAL ASSEMBLY THROUGH 10 MICRON FILTER
- PROVIDES THERMAL CONTROL OF AIR TO MAINTAIN $26 \pm 1^{\circ}$ TEMPERATURE RANGE
- SUPPLIES COOLING AIR TO CELL ELECTRONICS UNIT

BENCH FLUID LOOP HARDWARE

- PROVIDES HEATERS, SENSORS, HEAT EXCHANGER, AND PLUMBING PORTIONS OF CONTROL LOOP

CONSTRUCTION

- FRAME - 1-1/2" X 1-1/2" X 1/4" EXTRUDED ALUMINUM ANGLES
- PANELS - ONE SIXTEENTH INCH THICK ALUMINUM
- PLUMBING - STAINLESS STEEL TUBING WITH FLARED MS STAINLESS STEEL FITTINGS
- DOORS - ONE-HALF INCH HONEYCOMB WITH 0.02" AND 0.04" FACESHEETS



TRW/ASPO

FES EXPERIMENT ENCLOSURE
REQUIREMENTS VS CAPABILITY

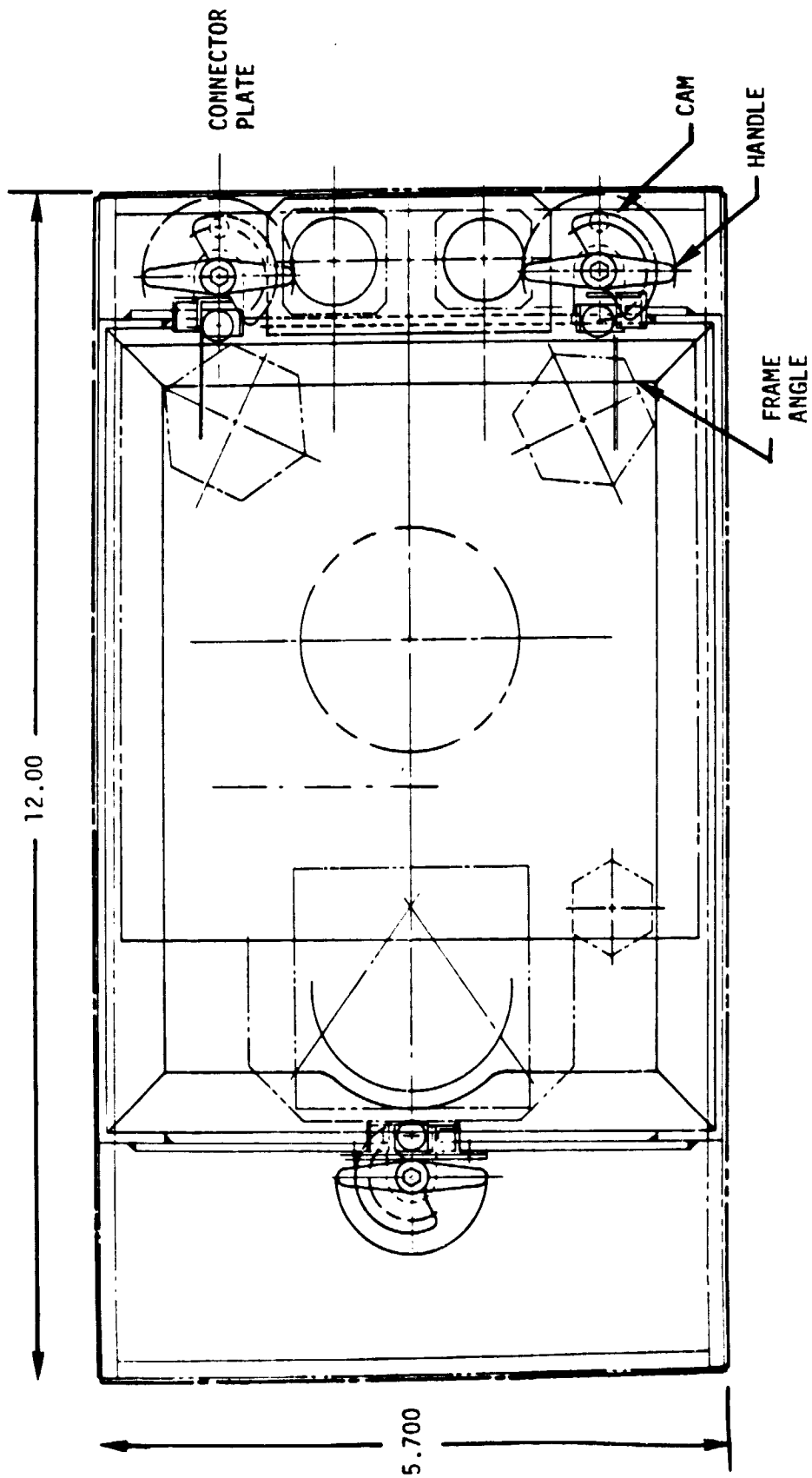
	<u>ALLOCATED REQUIREMENTS</u>	<u>CAPABILITY</u>
● <u>THERMAL PARAMETERS</u>		
● WATER LOOP:		
- CELL INLET TEMPERATURE RANGE	AMBIENT TO 200°C	AMBIENT TO 200°C
- CELL INLET TEMP CHANGE RATE	≥ 1°C/MIN	> 1°C/MIN
- HEAT REJECTION	> 600 WATT	> 700 WATT
● AIR LOOP		
- FLOW RATE	150 KG/HR	150 KG/HR
- INLET TEMPERATURE	26° ± 1°C	26° ± 1°C
- DOOR MAX. TEMPERATURE	45°C	27°C
- PARTICLE FILTER	10 MICRONS	10 MICRONS
- LEAKAGE	5ScCM AT 7MB	> 5ScCM*

• SPECIFICATION CHANGE REQUESTED



TRW/ASPO

PREHEAT ENCLOSURE



TRW/ASPO

FES PREHEAT ENCLOSURE FEATURES

ENCLOSURE

- ENCLOSURES TEST CELL DURING PREHEAT
- SUPPORTS THE PREHEAT FLUID CONTROL LOOP
- PROVIDES AIR DUCTING AROUND TEST CELL STING
- PROVIDES STORAGE OF TEST CELL UMBILICAL HARNESS

FLUID CONTROL LOOP HARDWARE

- PROVIDES HEATERS, SENSORS AND PLUMBING PORTIONS OF CONTROL LOOP

CONSTRUCTION

- FRAME – 1" X 1" X 1/8" EXTRUDED ALUMINUM ANGLES
- PANELS – ONE SIXTEENTH INCH THICK ALUMINUM
- PLUMBING – STAINLESS STEEL TUBING WITH FLARED MS STAINLESS STEEL FITTINGS
- DOORS – 0.04 INCH THICK ALUMINUM FACESHEETS



TRW/ASPO

FES PREHEAT ENCLOSURE
REQUIREMENT VS CAPABILITY

<u>THERMAL PARAMETERS</u>	<u>ALLOCATED REQUIREMENT</u>	<u>CAPABILITY</u>
• TEMPERATURE RANGE	AMBIENT TO 200°C	AMBIENT TO 200°C
• HEAT TO CELL FLUID	≥ 600 WATTS	628 WATTS
• STING HEAT REMOVAL	≥ 8 WATTS	10 WATTS
• HEAT LOSS INTO RACK AIR	< 450 WATTS	437 WATTS



TRW/ASPO

FES SUPPORT MODULE ELECTRONIC ASSEMBLIES

1. TRW UNITS

OCP

CEU

PEU

DEU

PCU

2. PURCHASED UNITS

PCDA

ACCELEROMETER

TV MONITOR



MECHANICAL CONFIGURATION FOR
TRW ELECTRONIC UNITS

CIRCUIT BOARDS

- MULTILAYER AND DOUBLE-SIDED PRINTED CIRCUIT BOARDS
- TYPICAL SIZE 7.9 INCH X 7.4 INCH

SLICE MODULES

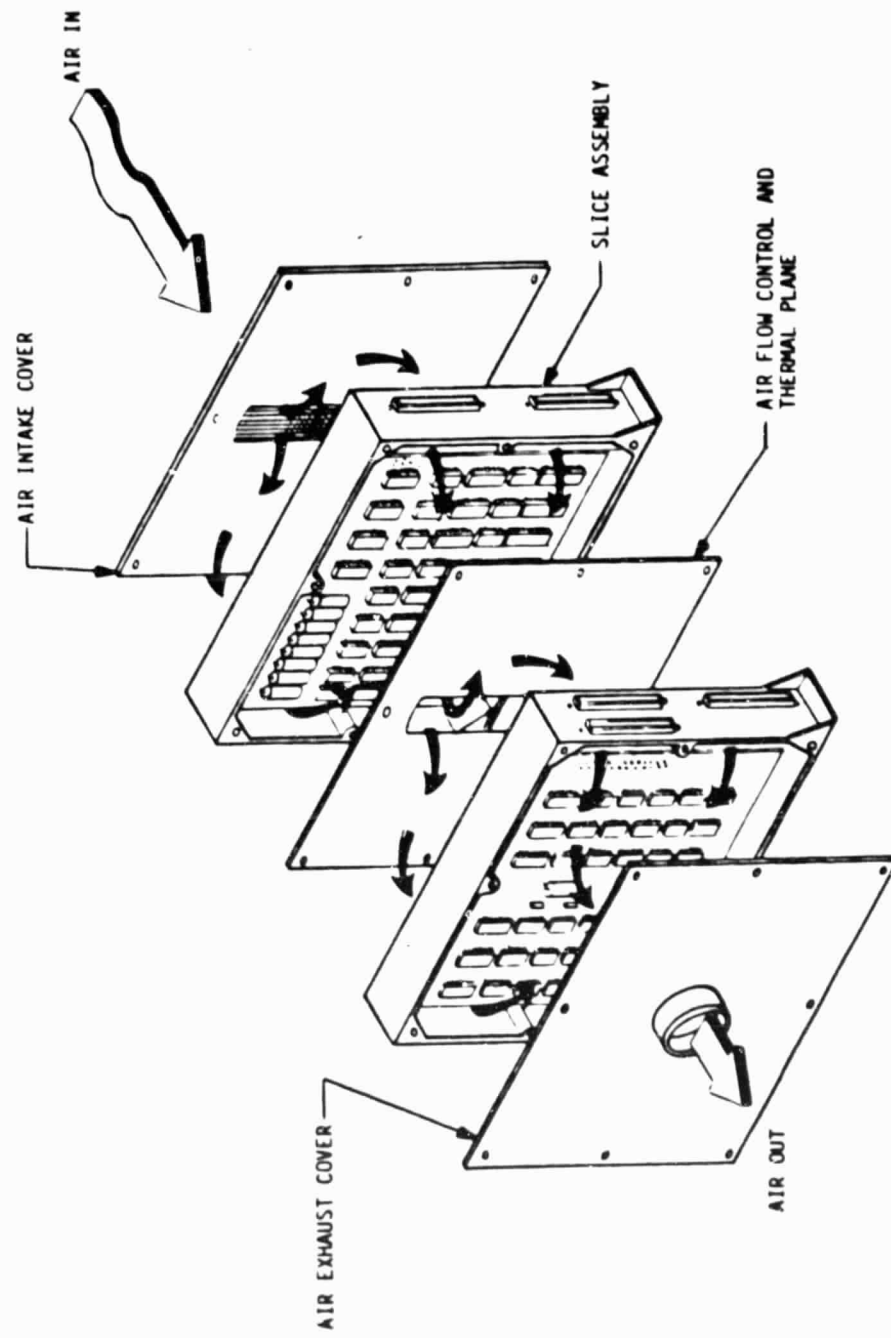
- HOUSING FOR 1 TO 3 CIRCUIT BOARDS
- ALUMINUM ALLOY INVESTMENT CASTING
- SAME HOUSINGS AS USED ON TDRSS PROGRAM

UNIT

- AN ASSEMBLY OF SLICE MODULES
- INCLUDES AVIONICS AIR INTAKE AND EXHAUST COVER PLATES

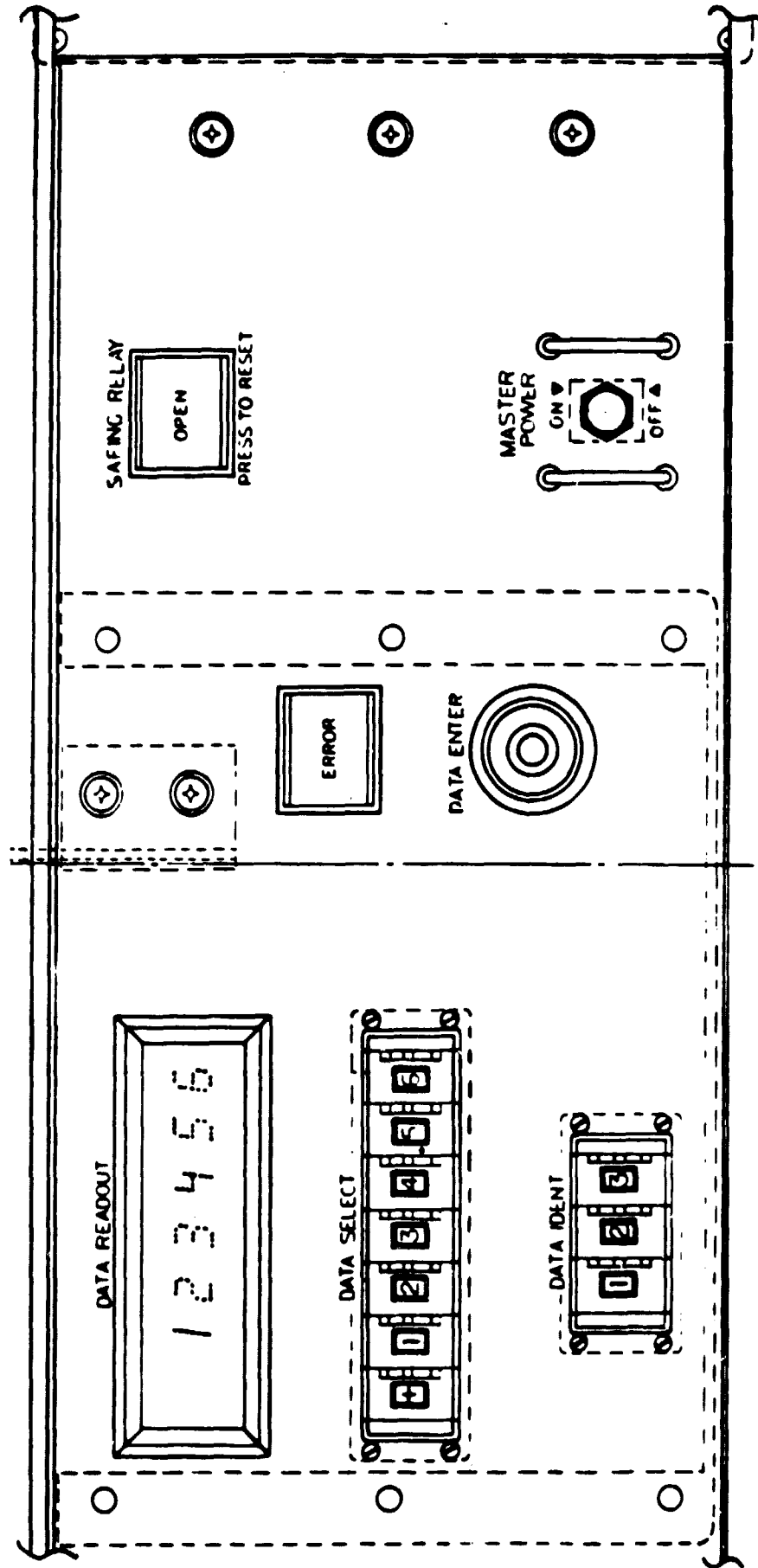


TYPICAL SLICE-EXPLODED VIEW



TRW/ASPO

OPERATOR CONTROL PANEL



TRW/ASPO

OPERATOR CONTROL PANEL UNIT

- FUNCTION
 - IMPLEMENTS INTERFACE WITH PAYLOAD SPECIALIST
 - DATA MONITORING
 - DATA ENTRY
 - ERROR SIGNALING
 - IMPLEMENTS EXPERIMENT DATA BUS CONVERTER
 - INTERFACES OTHER UNITS TO PCDA
 - CONVERTS PCDA MANCHESTER STREAM TO MULTIPLE EBI NRZ STREAMS
 - PROVIDES TELEVISION MONITOR
 - OPERATOR SELECTS FES OR VCG
 - SCHLIEREN VIEWING OF FES CRYSTAL
 - REPEATS MICROSCOPE VIEW OF VCG CRYSTAL



TRW/ASPO

OPERATOR CONTROL PANEL

● KEY REQUIREMENTS

- DATA MONITORING
NUMBER OF PARAMETERS
RANGE OF PARAMETERS
TYPE
UNITS

94
+XXX.XX
DIGITAL
ENGINEERING UNITS
- DATA ENTRY
NUMBER OF PARAMETERS
RANGE OF PARAMETERS
TYPE
UNITS
POWER ON/OFF

53
+XXX.XX
DIGITAL
ENGINEERING UNITS
POSITIVE ON/POSITIVE OFF W/GUARD
STD 525 LINE, 4.5 MHZ, B&W
ACTIVATED DUE TO ILLEGAL ENTRY,
EXCESS TEMPERATURE ERROR, OR
TRANSMISSION ERROR.
- SAFING INDICATION
WARNS P/S OF EXCESS TEMPERATURE
OR PRESSURE, OR DURING INITIALIZATION



TRW/ASPO

CELL ELECTRONICS UNIT

- FUNCTIONS
 - PROVIDE ALL CELL EE INTERFACES
 - SENSE TEMPERATURES
 - TRANSMIT WHEN REQUESTED BY PCDA VIA EBI/EBC
 - RTD TEMPERATURE SENSORS
 - DRIVE CELL HEATERS
 - HEATER VOLTAGE PROPORTIONAL TO COMMAND FROM PCDA
 - DRIVE STING THERMOELECTRIC ELEMENT
 - CURRENT PROPORTIONAL TO COMMAND FROM PCDA (COOLING OR HEATING)
 - DRIVE MOTOR
 - STIR PUMP DC MOTOR
VOLTAGE PROPORTIONAL TO COMMAND FROM PCDA



CELL ELECTRONIC UNIT

● KEY REQUIREMENTS

● TEMPERATURE SENSE RANGE ACCURACY STABILITY	26 0 - 200°C ± 0.02°C ± 0.006°C
● HEATER DRIVE POWER VOLTAGE ACCURACY	22 1, 20, 50 WATTS 0 TO 16 VOLTS 15% F.S.
● TE DRIVE CURRENT ACCURACY VOLTAGE	1 -0.5 TO 2 AMPS 60 MA +7 TO -4 VOLTS
● STIR PUMP DC MOTOR DRIVE VOLTS/AMPS SPEED	1 - BRUSHLESS DC 16 VCC @ 1.6 AMPS 3200 RPM



CELL ELECTRONICS UNIT

● CAPABILITIES

		<u>DESIGN</u>	<u>ANALYSIS</u>	<u>BREADBOARD TEST</u>
● TEMPERATURE SENSE	30	X		
RANGE	0-200			P
ACCURACY	+0.0085°C		X	X
STABILITY	+0.005°C (0.002-BB)		X	P
● HEATER DRIVE	23	X		
POWER	20, 50 WATTS			P
VOLTAGE	0 TO 16			P
ACCURACY	+15% F.S.		P	
● TE DRIVE	1	X		
CURRENT	-0.5 TO 2.0 AMPS			P
ACCURACY	6 MA		P	
VOLTAGE	+7 TO -4 VOLTS			
● STIR PUMP DC MOTOR DRIVE	1-BRUSHLESS DC	X		
VOLTS/AMPS	0 TO 16 VOLTS @ 3.0 AMPS			P
SPEED	3200 RPM			



TRW/ASPO

BENCH ELECTRONICS UNIT

● FUNCTIONS

- ACQUIRE DATA FOR TRANSMISSION TO PCDA
 - TEMPERATURE
BENCH AIR, WATER LOOP, ACCELEROMETER
 - SWITCH CLOSURES
LIMIT SENSORS
 - LASER INTENSITY
 - ACCELEROMETER DATA
- DRIVE STEPPER MOTORS ON COMMAND FROM PCDA
 - DRIVE FORWARD OR REVERSE A COMMANDED NUMBER OF STEPS
 - FILM TRANSPORTS, TWO POSITION OPTICS, PROP. VALVES, FOCUS LENS, 3 KNIFE EDGE
- ANNOTATE FILM
 - PRINT BINARY SEQUENTIAL NUMBERS ON EACH FILM FRAME



BENCH ELECTRONIC UNIT

● KEY REQUIREMENTS

● TEMPERATURE SENSE RANGE ACCURACY STABILITY	6 0 - 200°C ± 0.046°C ± 0.046°C
● STEPPER MOTOR DRIVE MOTOR TYPE VOLTAGE SPEED	12 4 PHASE, VAR. RELUCT. OR P/M, ≥35 OHMS 19 VOLTS MIN 200, 400 STEPS/SEC
● ACCELEROMETER INTERFACE SAMPLES/SECOND BITS PER SAMPLE/AXIS TEMP. SIGNAL TEMP. SIGNAL ACCURACY	1 300 ± 0.3 Hz 10 0 TO 0.8 VOLTS ± 0.2%
● LASER LIGHT SENSE DETECTOR VOLTAGE ACCURACY	1 0.006 TO 0.025 VOLTS ± 0.5%
● SENSE SWITCH CLOSURES	20



TRW/ASPO

BENCH ELECTRONICS UNIT

● CAPABILITIES

		<u>ESTABLISHED BY</u>	
		<u>DESIGN</u>	<u>ANALYSIS</u> <u>BREADBOARD TEST</u>
● TEMPERATURE SENSE	13	X	
RANGE	0-200°C		P
ACCURACY	+0.05°C		X
STABILITY	+0.024°C		X
● STEPPER MOTOR DRIVE	16	X	
MOTOR TYPE	SEE MECH. DESIGN	X	
VOLTAGE	19 VOLTS MIN		P
SPEED	200,400 PPS		P
● ACCELEROMETER INTERFACE	1	X	
SAMPLES/SECOND	300 ± 0.12		P
BITS PER SAMPLE/AXIS	10	X	
CLOCK RATE	25 KHZ		P
TEMP. SIGNAL	0 TO 0.8 VOLTS		P
TEMP. SIGNAL ACCURACY	±0.1%		P
● LASER LIGHT SENSE	1	X	
DETECTOR VOLTAGE	0 TO 0.7 VOLTS		P
ACCURACY	±0.1%		P
● SENSE SWITCH CLOSURES	32	X	



PREHEAT ELECTRONICS UNIT

- FUNCTIONS
 - PROVIDE ELECTRICAL/ELECTRONIC SERVICE TO CELL IN PREHEAT
 - TEMPERATURE MEASUREMENT
 - HEATER DRIVE
 - THERMOELECTRIC DRIVE
 - STIRRER PUMP
 - PROVIDE MEASUREMENT OF H₂O LOOP TEMPERATURE



TRW/ASPO

PREHEAT ELECTRONICS UNIT

● KEY REQUIREMENTS (PEU)

●	TEMPERATURE SENSE	13
	RANGE	AMBIENT TO 200°C
	ACCURACY	$\pm 0.8^{\circ}\text{C}$
	STABILITY	$\pm 0.08^{\circ}\text{C}$
	RESOLUTION	$\pm 0.06^{\circ}\text{C}$
●	HEATER DRIVE	10
	POWER	50 WATTS
	VOLTAGE	0-16 VOLTS
	ACCURACY	15% OF F.S.
●	THERMOELECTRIC DRIVE	1
	CURRENT	-0.5 TO 2 AMPS
	VOLTAGE	+7 TO -4 VOLTS
	ACCURACY	$\pm 60 \text{ MA}$



PREHEAT ELECTRONICS UNIT

● CAPABILITIES

		DESIGN	ESTABLISHED BY	
			ANALYSIS	BREADBOARD TEST
● TEMPERATURE SENSE		X		
RANGE	15			P
ACCURACY	0-200°C			
STABILITY	0.6°C		X	
RESOLUTION	0.02°C		X	P
	0.003°C		X	
● HEATER DRIVE		X		
POWER	12			
VOLTAGE	50 WATTS			P
ACCURACY	0-16 VOLTS			P
	15% OF F.S.			P
● THERMOELECTRIC DRIVE		X		
CURRENT	1			
VOLTAGE	-0.5 TO +2.0 AMPS			P
ACCURACY	+7 TO -4 VOLTS			P
	+ 60 MA			



POWER CONTROL UNIT (PCU)

- FUNCTIONS
 - SWITCH PRIMARY POWER
 - FES PRIMARY POWER FROM FES EPSP
 - VCG PRIMARY POWER FROM VCG EPSP (SHARED FUNCTION)
 - PRIMARY POWER CONTROLLED BY FRONT PANEL SWITCHES
 - GENERATE CONDITIONED SECONDARY POWER FOR FES
 - PROVIDE ALL SWITCHED POWER DRIVE FUNCTIONS
 - POWER TO SWITCHABLE UNITS (PEU, BEU, CEU)
 - FAN ON/OFF (BENCH AIR, VCGS AIR)
 - PUMP ON/OFF (PLATEN VACUUM, PREHEAT WATER, BENCH WATER, STING VACUUM)
 - LASER POWER SUPPLY ON/OFF
 - ALL POWER TO VARIABLE TRANSFORMERS
 - DRIVE WATER LOOP HEATERS
 - STEPPER MOTOR DRIVER VARIABLE TRANSFORMER
 - SENSE LIMIT SWITCH POSITIONS ON AUTOTRANSFORMERS
 - PROVIDE ELECTRICALLY HELD RELAYS FOR HAZARD SAFING
 - RELAYS DRIVEN THROUGH PRESSURE/TEMP SENSORS



TRW/ASPO

POWER CONTROL UNIT (PCU)

- KEY REQUIREMENTS
 - SWITCH FES PRIMARY POWER
 - DC VOLTAGE/CURRENT 28 ± 4 VOLTS
 - AC VOLTAGE/CURRENT 115 ± 5% VOLTS, 3 PHASE { 1KW AVE.
 - SWITCH VCG PRIMARY POWER
 - DC VOLTAGE/CURRENT 28 ± 4 VOLTS CEI 24 @ 500 WATTS AVE.
 - AC VOLTAGE/CURRENT 115 ± 5% VOLTS, 3 PHASE @ 150 VA AVE.
 - GENERATE AND SWITCH SECONDARY POWER LEVELS
 - VOLTAGE LEVELS +28, +15, +12, +5, +5.5, -15 VOLTS
 - CURRENTS 1.6, 1.2, 3.6, 14.5, 6.3, 2.1 AMPS
 - ACCURACY ±5% AND ±10%
 - RELAY/SOLENOID DRIVE
 - QUANTITY 22
 - VOLTAGE 28 ± 1/4 VDC
 - PULSE WIDTH 25 MS MIN
 - STEPPER MOTOR DRIVE (H₂O HEATER CONTROL)
 - 2
 - VAR. RELUCT, 4 PHASE, SIZE 8
 - 19V MIN
 - 200 STEPS/SEC
 - 8
 - PROVIDE SAFETY RELAYS



POWER CONTROL UNIT (PCU)

CAPABILITIES	ESTABLISHED BY	
	<u>DESIGN</u>	<u>ANALYSIS</u> <u>TEST</u>
● SWITCH FES PRIMARY POWER		
DC VOLTAGE/CURRENT	28±4 VOLTS @ 45 AMPS	X
AC VOLTAGE/CURRENT	115/3/400 V/Ø/HZ @ 10A	X
● SWITCH VCG PRIMARY POWER		
DC VOLTAGE/CURRENT	28±4 VOLTS @ 794 WATTS	X
AC VOLTAGE/CURRENT	115±5% V, 3Ø @ 1035 VA	X
● GENERATE AND SWITCH SECONDARY POWER LEVELS		
VOLTAGE LEVELS	SAME	
CURRENTS	1.8,2.1,4.3,17.6,9,3	X
ACCURACY	±1% & 10% (5.5V & 12V)	
● RELAY/SOLENOID DRIVE		X
QUANTITY	22	X
VOLTAGE	28±0.1 V DC	X
PULSE WIDTH	48 MS ± 2 MS	X
● STEPPER MOTOR DRIVE		
(H ₂ O HEATER CONTROL)	4	X
TYPE	A/R	X
VOLTS	19 VOLTS MIN	X
SPEED	400 STEPS/SEC	
● PROVIDE SAFETY RELAYS	PROVIDED	X



TRW/ASPO

ELECTRONICS BREADBOARD TESTING

UNIT	TEST
<ul style="list-style-type: none"> ● ELECTRONIC CIRCUITS <ul style="list-style-type: none"> ● TEMP SENSE ● HEATER LOGIC ● STEP MOTOR DRIVE ● RELAY LOGIC ● BUS INTERFACE ● A/D CONVERTER ● HEATER DRIVE ● T.E. DRIVE ● ACCELEROMETER I/F ● CAMERA I/F ● BUS CONVERTER ● OPERATOR CONTROL PANEL 	<ul style="list-style-type: none"> ● CIRCUIT FUNCTIONS ● CIRCUIT AND DISPLAY FUNCTIONS
● ELECTRONICS UNIT MECHANICAL SLICE	● COOLING AIR PRESSURE DROP
● STEPPER MOTORS	● MOTOR CONTROL AND TORQUE
● A1 9551 USART PART	● RESET CHARACTERISTICS
● TV MONITOR	● VIBRATION INTEGRITY

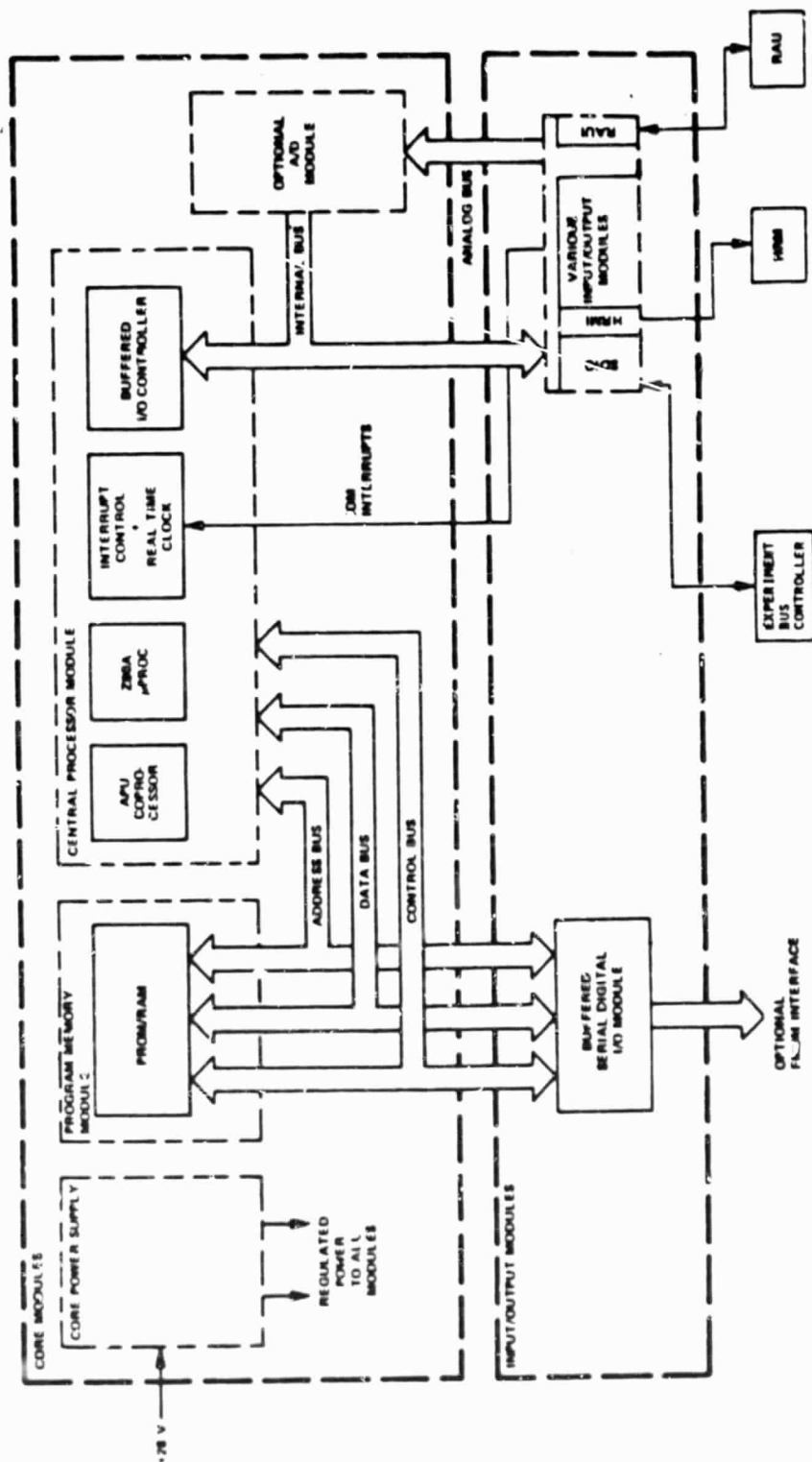


TRW/ASPO

PURCHASED ELECTRONIC ASSEMBLIES

1. PCDA
2. ACCELEROMETER
3. TV MONITOR

PROCESS CONTROL AND DATA ACQUISITION



TRW/ASPO

PROCESS CONTROL AND DATA ACQUISITION UNIT

● FUNCTIONS

- MAINTAIN SEQUENCE TIMELINE FOR SEVERAL EXPERIMENT PROCESSES
- CONTROL UP TO 200 EXPERIMENT FUNCTIONS
- COLLECT AND PROCESS EXPERIMENT DATA - UP TO 300 16-BIT DATA POINTS
- FORMAT AND TRANSMIT DATA TO THE HIGH RATE MULTIPLEXER
- PROVIDE TIMING INTERFACE TO REMOTE ACQUISITION UNIT
- PROVIDE DATA INTERFACE TO EXPERIMENT BUS CONVERTER
- STORE CALIBRATION CONSTANTS
- CONVERT DATA TO ENGINEERING UNITS



TRW/ASPO

PROCESS CONTROL AND DATA ACQUISITION UNIT

● KEY REQUIREMENTS AND CAPABILITIES

- HRM INTERFACE
DATA AND CLOCK OUT
 - RAU INTERFACE
UTC, UTC - UPDATE
 - SERIAL DIGITAL I/O CHANNELS
DATA
WORD DISCRETE
MESSAGE IN/OUT DISCRETE
 - MEMORY - SEMICONDUCTOR
 - CPU
 - PROCESSOR
 - ARITHMETIC PROCESSOR UNIT
- | | |
|---|---|
| 1 | DIFFERENTIAL NRZ - 0.5 TO 1.5 VOLTS |
| 1 | DIFFERENTIAL - TTL LEVELS |
| 2 | MANCHESTER II - BIPHASE- L-1MBPS-3 TO 6 VOLTS
DIFFERENTIAL - TTL LEVEL |
| | 15.8 KBYTES PROM, 4.4 KBYTES RAM |
| | Z80 A |
| | 9511 |



ACCELEROMETER

- FUNCTIONS
 - SENSE MICRO-G ACCELERATION LEVELS ON OPTICAL BENCH
 - PROVIDE SERIAL OUTPUT DATA ON COMMAND
 - PROVIDE SELF TEMPERATURE MEASUREMENT FOR DATA CALIBRATION



TRW/ASPO

ACCELEROMETER

● KEY REQUIREMENTS

● RANGE

0 TO 10^{-2} G

● AXES

3 ORTHOGONAL

● BANDWIDTH

0 TO 50 HZ (3 DB)

● ACCURACY

$\pm 50 \mu\text{G}$ (IN 50 HZ BW)

● TEMPERATURE OUTPUT

SELF IMPOSED REQUIREMENT
FOR DATA REDUCTION

● DATA OUTPUT

- FORMAT

DATA CLOCKED OUT SERIALY
BY EXTERNAL COMMAND

- DATA RATE

300 SAMPLES/SECOND,
10 BITS PER SAMPLE/AXIS



ACCELEROMETER

● CAPABILITIES

● RANGE

BY DESIGN

● AXES

BY DESIGN

● BANDWIDTH

BY DESIGN AND DATA REDUCTION

● ACCURACY

CALIB ERROR = $\pm 1 \mu G$ MAX

HULL OFFSET ERROR = $\pm 0.5 \mu G$

NOISE EQUIV ACCELERATION =

$8 \mu G$ (10 - 50 HZ BW)

● TEMPERATURE OUTPUT

0-5 VOLT ANALOG

ACCURACY $\pm 0.5^{\circ}C$

● DATA OUTPUT

- FORMAT

BY DESIGN

- DATA RATE

BY DESIGN



TV MONITOR BALL BROTHERS VM-103A

MECHANICAL

DIMENSIONS/WEIGHT:

6.0" X 7.8" X 10.3"/13 POUNDS

CONTROLS:

- FRONT:
- MAINTENANCE:

CONTRAST, BRIGHTNESS
(ACCESSIBLE ON TOP) FOCUS,
HEIGHT, WIDTH, HORIZONTAL
LINEARITY, VERTICAL LINEARITY,
HORIZONTAL HOLD

TEST POINTS:

ACCESSIBLE ON REAR

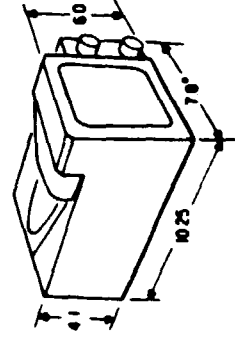
CONNECTORS:

- VIDEO
- POWER

BNC ON REAR
MS ON REAR

FSN:

1270 - 420 - 1134 AY



TV MONITOR

ELECTRICAL

ELECTRICAL INPUT:

- POWER:
- VOLTAGE:

45 WATTS

28 VDC \pm 4 V

VIDEO IMPEDANCE:

75 OHMS

LINE RATE:

525PER EIA RS-170

BANDWIDTH:

32 Hz TO 5.5 MHz \pm 1 DB

RESOLUTION (LIMITING):

- HORIZONTAL:
- VERTICAL:

550 TVL AT 50 FT-L

360 TVL

HORIZONTAL/VERTICAL LINEARITY:

< 5%, TYPICALLY 2%

GEOMETRIC DISTORTION:

< 5%

CRT SIZE:

6 INCH DIAG., 1:1 ASPECT RATIO,
4.5" X 4.5" USEFUL SCREEN AREA

PHOSPHOR:

P-4

BRIGHTNESS:

25 FT-L, 100 FT-L WITH IMPLOSION
PANEL/FILTER



TRW/ASPO

TV MONITOR

ENVIRONMENT

TEMPERATURE:

- OPERATING:
-40°C TO +55°C
- NONOPERATING:
-55°C TO +85°C

ALTITUDE:

0 TO 30,000 FEET

VIBRATION:

0.06" DOUBLE AMPLITUDE
5-32 Hz, 5G 32-500 Hz

HUMIDITY:

95%

EMI:

MIL-STD-461

COATINGS:

EMI/ANTI-REFLECTIVE

RELIABILITY

MTBF:

1500 HOURS

SAFETY:

CAST CRT HOUSING AND IMPLOSION
PANEL, ENCAPSULATED HIGH VOLTAGE
POWER SUPPLY AND HIGH VOLTAGE
ANODE LEAD, NO EXTERNAL POTENTIALS,
EXPLOSION-PROOF PER MIL-STD-810B



FES STORAGE ENCLOSURES

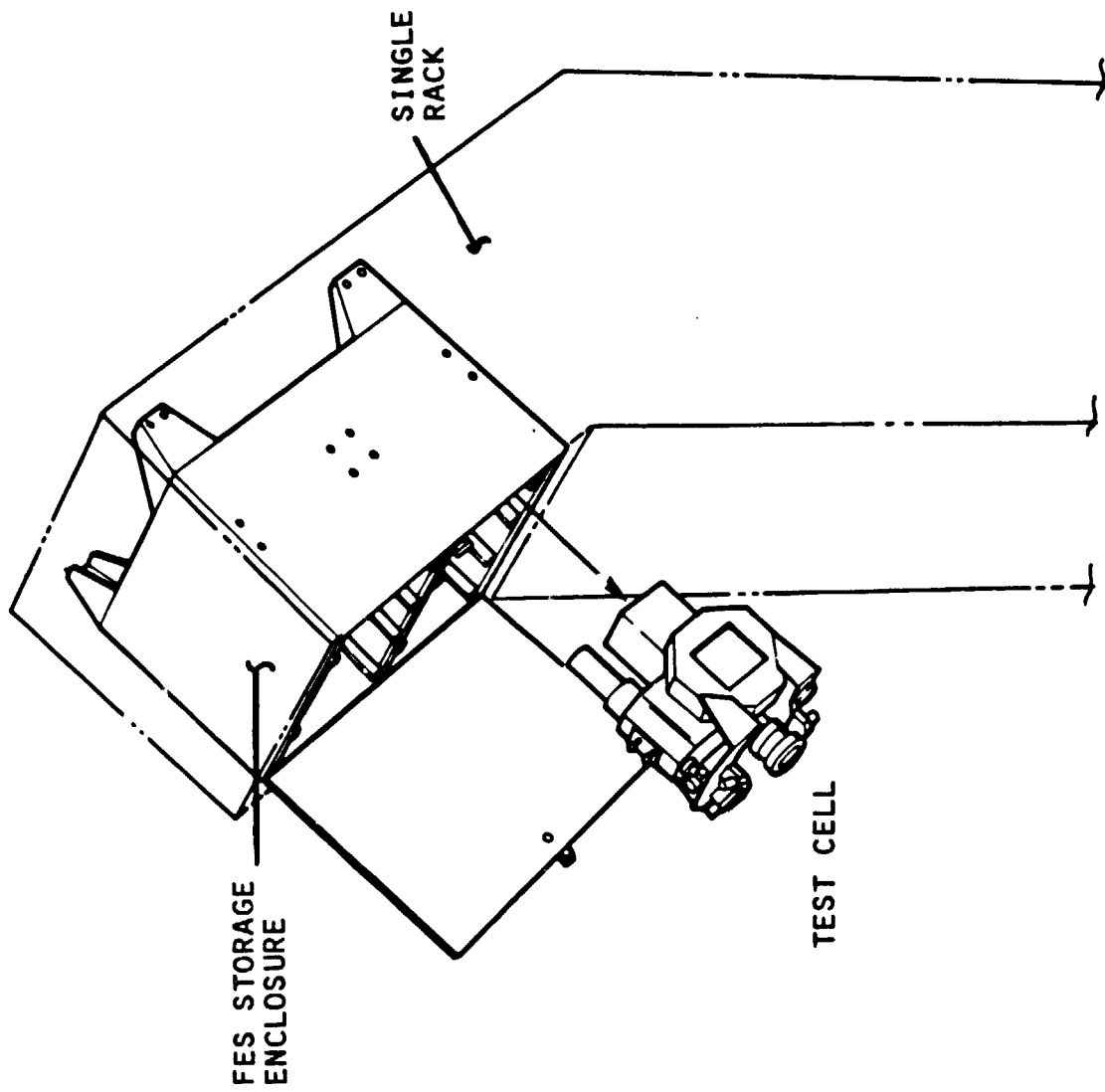
TWO UNITS REQUIRED

ONE LOCATED IN TOP PORTION OF VCGS RACK 12

RECOMMEND LOCATING SECOND ENCLOSURE IN THE UPPER PORTION
OF RACK 7

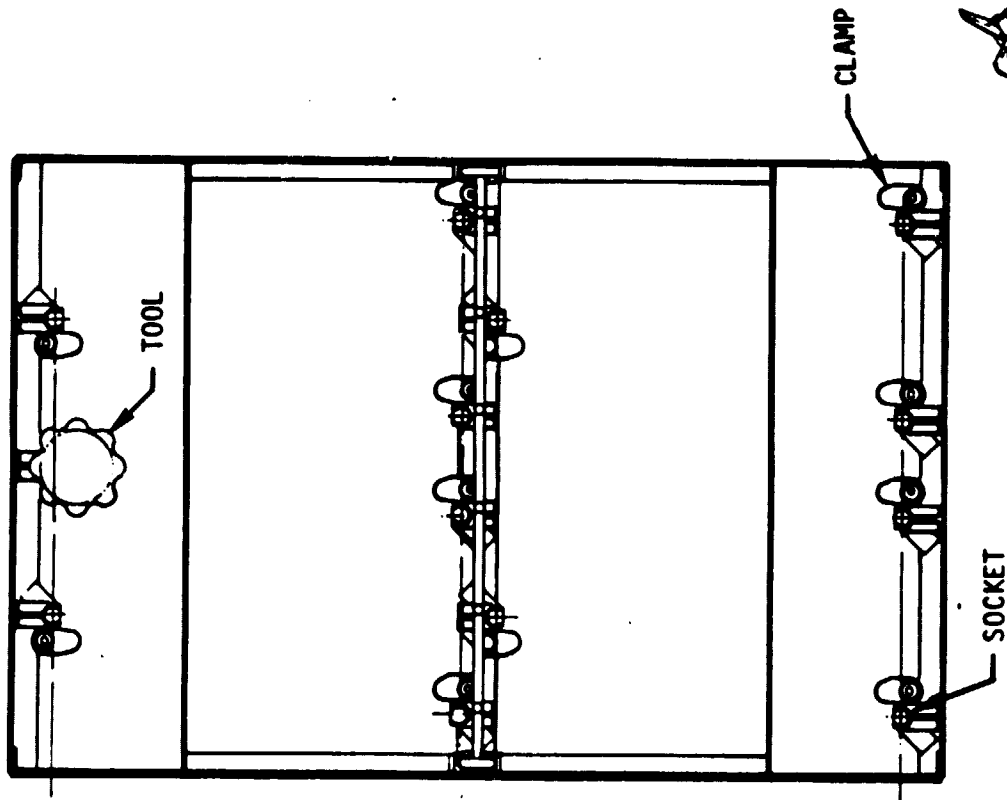
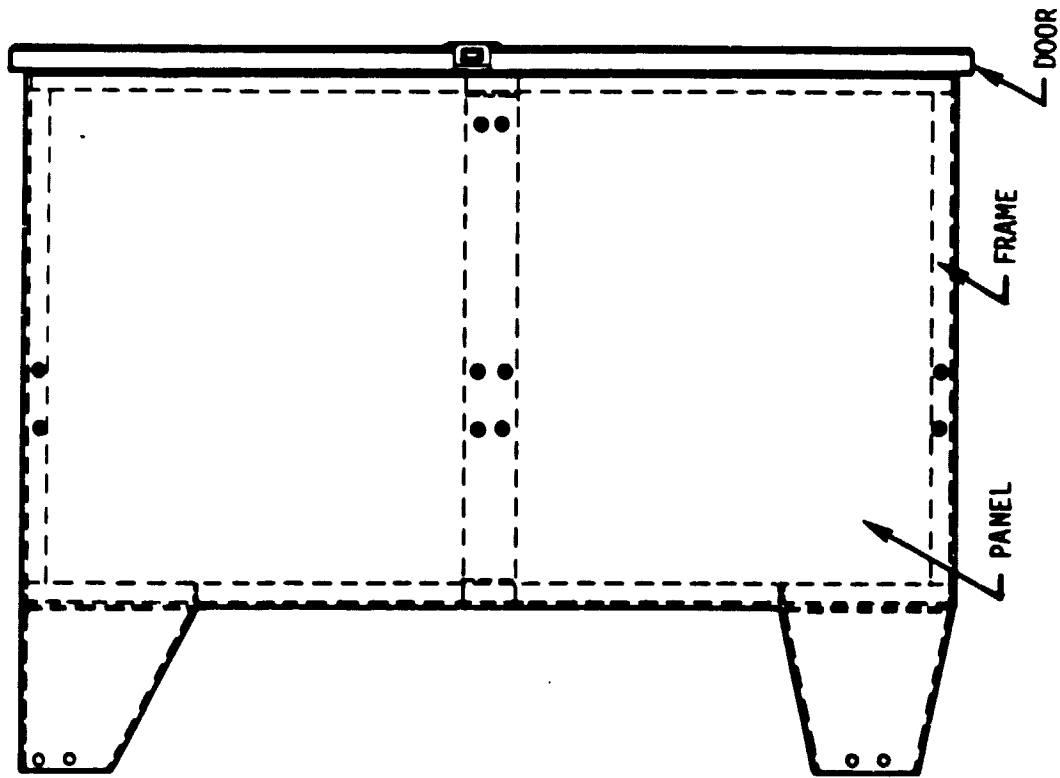


FES STORAGE ENCLOSURE



TRW/ASPO

STORAGE ENCLOSURE



TRW/ASPO

FES STORAGE ENCLOSURE FEATURES

ENCLOSURE

- ENCLOSURES 4 TEST CELLS OR 3 TEST CELLS AND 1 CALIBRATION CELL
- SUPPORT BRACKETS DESIGNED FOR MOUNTING IN TOP PORTION OF RACK
- TWO IDENTICAL ENCLOSURES TO BE FABRICATED

CONSTRUCTION

- FRAME - 5/8" X 5/8" X 1/16" ALUMINUM ANGLES AND 1-1/2" X 1/2" X 1/8" ALUMINUM CHANNEL
- PANELS - .032" THICK ALUMINUM
- DOORS - .56 INCH HONEYCOMB WITH .04" FACESHEETS
- REAR SUPPORTS - ALUMINUM PLATE 1-3/8" WIDE X 7/8" THICK
- GUIDES - 5/8" TUBING



TRW/ASPO

STORAGE ENCLOSURE

	<u>REQUIREMENT</u>	<u>CAPABILITY</u>
● NO. OF CELLS/ENCLOSURE*	4 TEST OR 3 TEST & 1 CALIBRATION	4 TEST OR 3 TEST & 1 CALIBRATION
● TEMPERATURE ENVIRONMENT	10°C TO 45°C	10°C TO 45°C
● STOWING & UNSTOWING	CREW - 1 HAND	CREW - 1 HAND
● WEIGHT	≤ 19KG	≤ 11 KG

- WEIGHT LIMITATIONS, FOR TOP PORTION OF RACK, ONLY ALLOW STORAGE OF TWO TEST CELLS AND ONE CALIBRATION CELL DURING STS ASCENT/DESCENT



TRW/ASPO

FES SYSTEM REQUIREMENTS VS CAPABILITIES

ALL CEI REQUIREMENTS ARE MET EXCEPT FOR -

RECOMMENDED SPECIFICATION CHANGES

- FLUID SENSOR LOCATION: CHANGE 2.5CM TO 2.7CM
- SEALED ENCLOSURES: DELETE REQUIREMENT FOR 0.5 SCCM LEAKAGE AT 7 MILLIBARS PRESSURE

DEVIATION REQUESTS

- ONE MEGOHM ISOLATION 28V RETURN/SECONDARY GROUND: PCDA AND ACCELEROMETER 500 OHM AND 300 OHM AT 25 HZ
- MATERIALS/PARTS/PROCESSES AND ENVIRONMENT: PCDA DOES NOT FULLY COMPLY, BUT WAS PREVIOUSLY QUALIFIED FOR SHUTTLE
- 2.5 MEGOHM BONDING REQUIREMENT: THREE STEPPER MOTORS RESISTANCE TO GROUND IS ONE TENTH OHM
- FUSE SHOULD BLOW BEFORE EPDS BREAKER TRIPS: 300% BLOW TIME ON 15 AMP FUSES EXCEEDS SPAH ALLOWABLE



TRW/ASPO

VAPOR CRYSTAL GROWTH SYSTEM
CDR DESIGN OVERVIEW

C4-1



TRW/ASPO

VAPOR CRYSTAL GROWTH SYSTEM
(VCGS)

- EXPERIMENT
 - MERCURIC IODIDE CRYSTAL GROWTH
- PRINCIPAL INVESTIGATOR
 - W. SCHNEPPLE, EG&G, COLETA, CA.
- SCIENCE OBJECTIVES
 - IMPROVE HgI_2 CRYSTAL GROWTH
 - OBTAIN LOW-G VAPOR TRANSPORT DATA

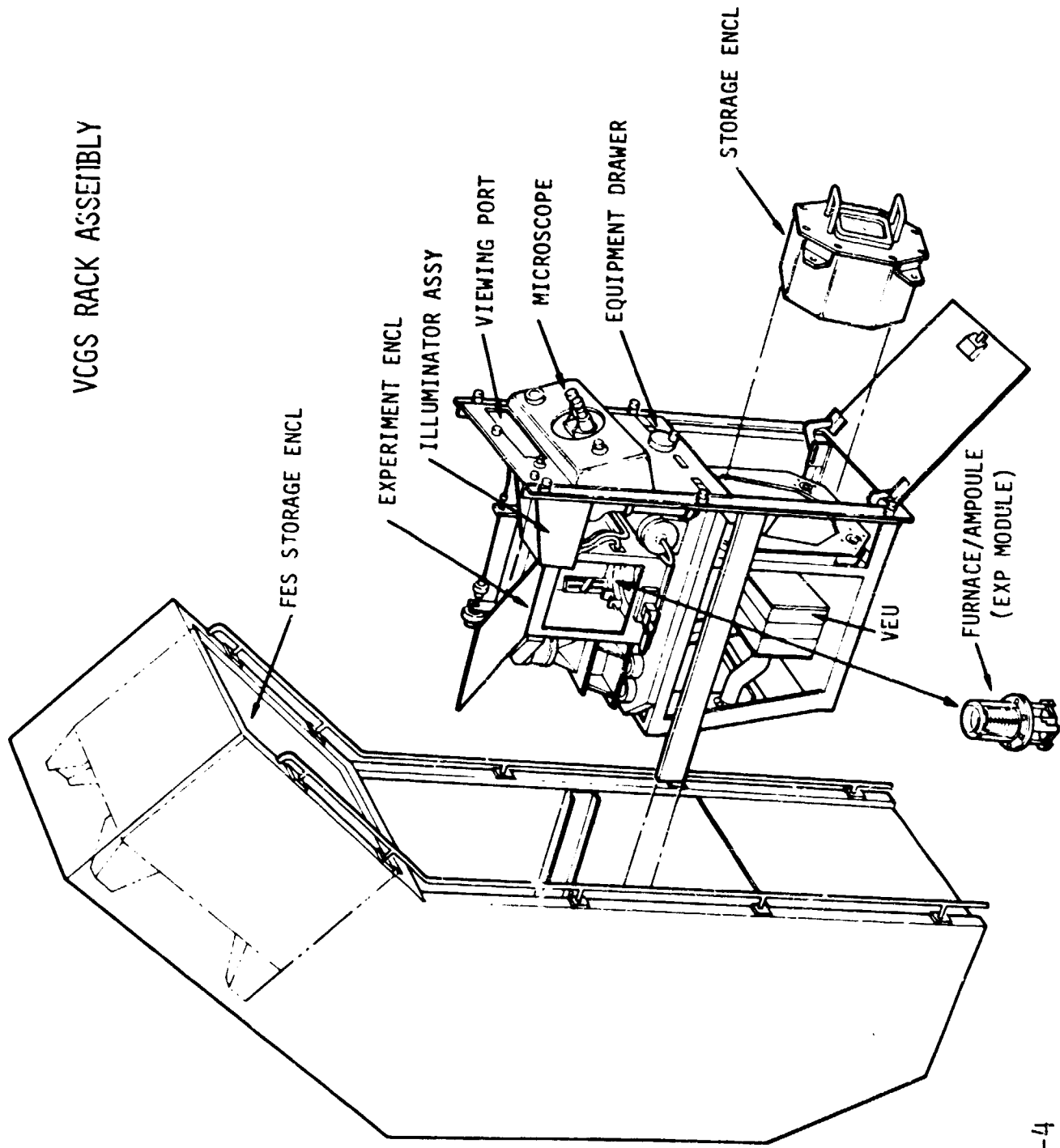


PRESENTATION OVERVIEW

- RACK ASSEMBLY
- UNIT FUNCTIONS
- UNIT DESIGN REVIEW
 - UNIT ASSEMBLY
 - FEATURES/KEY COMPONENTS
 - REQUIREMENTS VERSUS CAPABILITIES
 - BREADBOARD TESTS
- SYSTEM REQUIREMENTS VERSUS CAPABILITIES
 - CEI SPEC CHANGES/WAIVERS



VCGS RACK ASSEMBLY



TRW/ASPO

UNIT FUNCTIONS

- FURNACE/AMPOULE UNIT (F/AU)
 - PROVIDE HOUSING FOR HgI₂ CRYSTAL/SOURCE MATERIAL (AMPOULE)
 - PROVIDE CONTROLLED SPATIALLY-UNIQUE TEMP DISTRIBUTION ON AMPOULE (FURNACE)
- EXPERIMENT ENCLOSURE UNIT (EEU)
 - PROVIDE EM HOUSING (GROWTH MODE)
 - PROVIDE CONTROLLED THERMAL ENVIRONMENT FOR EM
 - PROVIDE SAFING
- STORAGE ENCLOSURE UNIT (SEU)
 - PROVIDE EM STOWAGE (GROUND HANDLING/LAUNCH/ASCENT/DESCENT/LANDING)
 - PROVIDE PASSIVE THERMAL CONTROL
 - PROVIDE VIBRATION ISOLATION
 - PROVIDE G-VECTOR ALIGNMENT



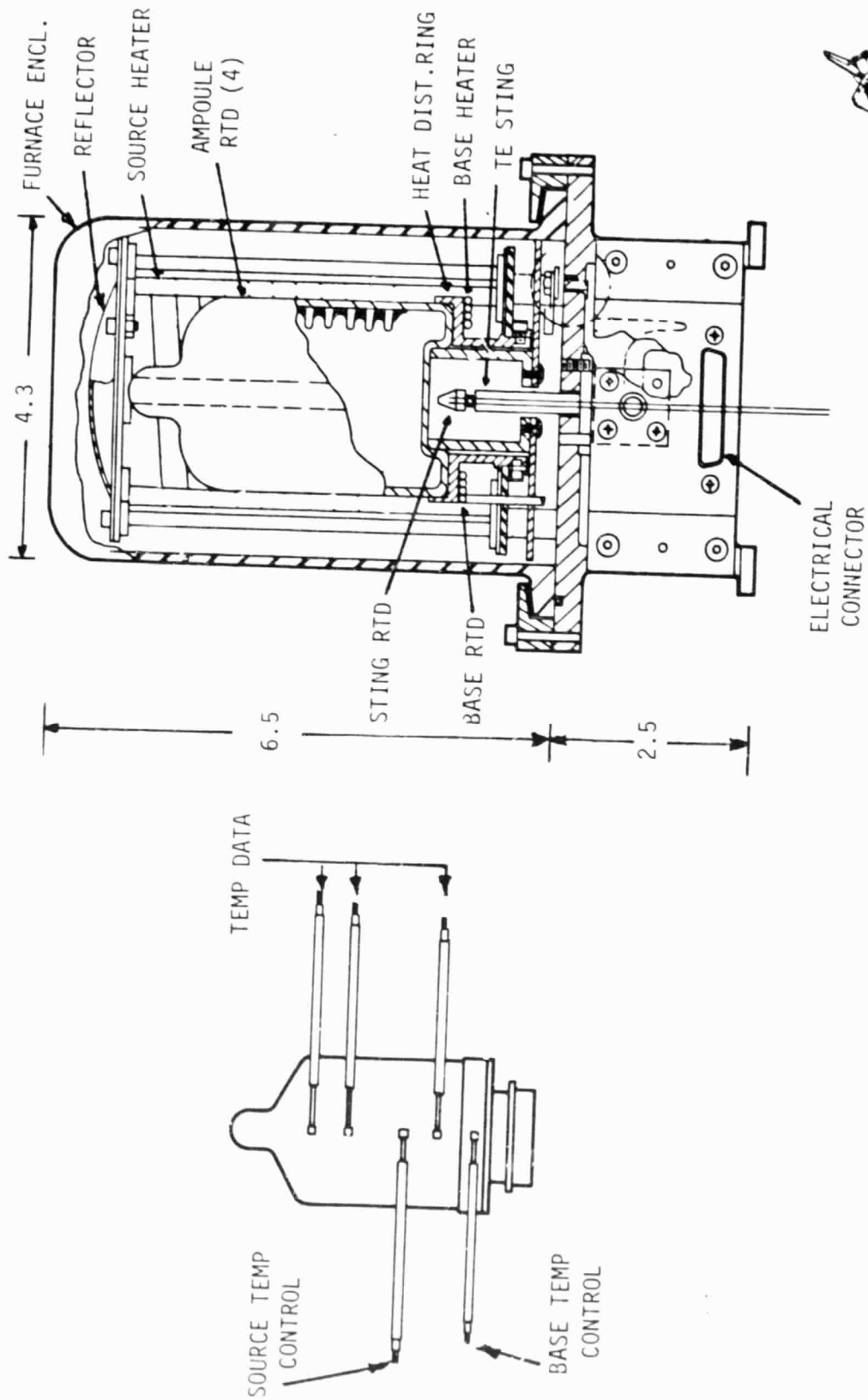
UNIT FUNCTIONS

- ELECTRONICS UNIT (VEU)
 - PROVIDE TEMP SENSE/SIGNAL CONDITIONING
 - PROVIDE 2-WAY SERIAL DATA TO PCDA
 - PROVIDE VARIABLE VOLTAGE DRIVE (HEATERS)
 - PROVIDE VARIABLE CURRENT DRIVE (TE STING)
 - DEVELOP SECONDARY POWER LEVELS
 - PROVIDE SYSTEM SAFING RELAYS
- OPTICAL ASSEMBLY UNIT (OAU)
 - PROVIDE MEANS FOR VIEWING/IMAGING CRYSTAL/SOURCE MATERIAL
- EQUIPMENT DRAWER UNIT (EDU)
 - PROVIDE SUPPORTING STRUCTURE FOR VCGS-UNIQUE EQUIPMENT
 - PROVIDE MANUAL CONTROLS
 - PROVIDE G-VECTOR ALIGNMENT (LAUNCH/ASCENT/DESCENT/LANDING)



TRW/ASPO

FURNACE/AMPOULE ASSEMBLY



TRW/ASPO

FURNACE/AMPOULE FEATURES/KEY COMPONENTS

- FURNACE ENCLOSURE (BELL JAR)
- HELICAL SOURCE HEATER
- BASE HEATER
- TE STRING
- AMPOULE
- TEMP CONTROL SENSORS (RTDs)
- TEMP DATA SENSORS (RTDs)



TRW/ASPO

FURNACE/AMPOULE REQUIREMENTS/CAPABILITIES

<u>DESIGN FEATURE</u>	<u>REQUIREMENT</u>
● FURNACE/AMPOULE	● DESIGN/CONSTRUCTION PER PI'S DESIGN
● BASE HEATER	● SETPOINT RANGE: 120°C TO 160°C
	● NOMINAL HEATING RATE $\leq 41^{\circ}\text{C}/\text{HR}$
● SOURCE HEATER	● SETPOINT RANGE: 100°C TO 120°C
	● NOMINAL HEATING RATE $\leq 37^{\circ}\text{C}/\text{HR}$
	● COLD SPOT AT SOURCE MATERIAL LOCATION
● THERMIST	● SETPOINT RANGE: 40°C TO 60°C
	● NOMINAL HEATING RATE $\leq 12^{\circ}\text{C}/\text{HR}$
● TEMP SENSORS	● 3 TEMP CONTROL RTDs
	● 4 TEMP DATA RTDs ON AMPOULE (LONGITUDINAL TEMP DISTRIBUTION)
	● ALLOCATED SENSOR ERRORS <ul style="list-style-type: none"> ○ ACCURACY $\leq \pm 0.4^{\circ}\text{C}$ ○ STABILITY $\leq \pm 0.03^{\circ}\text{C}$ ○ REPEATABILITY $\leq \pm 0.03^{\circ}\text{C}$



FURNACE/AMPOULE REQUIREMENTS/CAPABILITIES

CAPABILITY	VERIFICATION METHOD
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● ANALYSIS/DESIGN
● HEATING RATE: 0 TO 160°C/HR	● ANALYSIS/BB TESTS
● PER REQUIREMENT	● ANALYSIS/DESIGN
● HEATING RATE: 0 TO 170°C/HR	● ANALYSIS/BB TESTS
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● ANALYSIS/DESIGN
● HEATING RATE: 0 TO 12°C/HR	● ANALYSIS/BB TESTS
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● DESIGN
● SENSOR ERRORS	● PAST PERFORMANCE (ROSEMONT #118 MF RTD)

- ACCURACY $\leq \pm 0.4^{\circ}\text{C}$
- STABILITY $\leq \pm 0.02^{\circ}\text{C}$
- REPEATABILITY $\leq \pm 0.02^{\circ}\text{C}$



FURNACE/AMPOULE REQUIREMENTS/CAPABILITIES

<u>DESIGN FEATURE</u>	<u>REQUIREMENT</u>
● FURNACE ENCLOSURE	● WITHSTAND 1.5 PSI ΔP (EITHER DIRECTION)
	● LEAKAGE ≤ 0.01 SCCM HE, $\Delta P = 1.6 \times 10^{-5}$ N/M ²
● FURNACE ENCLOSURE/AMPOULE	● OPTICAL QUALITY PER PIs
● FURNACE	● WORKING VOLUME: D = 9.5 CM, L = 15.0 CM
● AMPOULE	● ENVELOPE: OD = 6.0 CM, L = 11 CM
	● CRUSH PRESSURE = 1.5 ATM AT 160°C



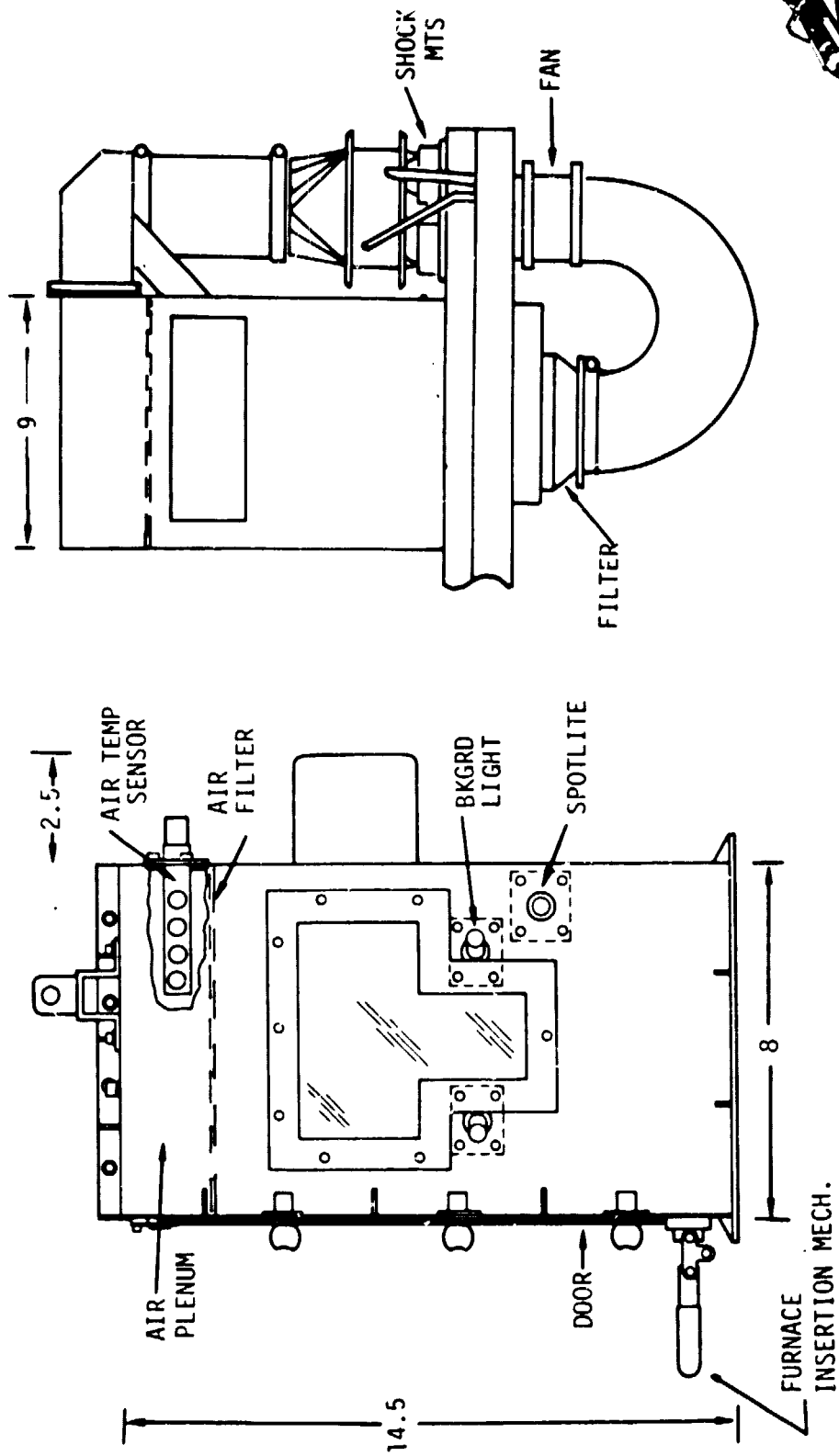
FURNACE/AMPOULE REQUIREMENTS/CAPABILITIES

<u>CAPABILITY</u>	<u>VERIFICATION METHOD</u>
● TBD	● *
● PER REQUIREMENT	● ANALYSIS/DESIGN
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● DESIGN
● TBD	● *

* UNIT QUAL TO BE PERFORMED



EXPERIMENT ENCLOSURE



TRW/ASPO

EXPERIMENT ENCLOSURE FEATURES/KEY COMPONENTS

- CLOSED-LOOP AIR CONDITIONING ASSEMBLY
 - LOOP AIR/WPE WATER HEAT EXCHANGER
 - FAN
 - TRIM HEATER
 - TEMP CONTROL SENSOR (RTD)
 - AIR PLENUM
 - AIR FILTER(S)
- OVERPRESSURE CHAMBER
- POLAR ROTATOR ASSEMBLY
- VIEWING PORT
- REDUNDANT SAFING THERMAL SWITCH



EXPERIMENT ENCLOSURE REQUIREMENTS/CAPABILITIES

DESIGN FEATURE

REQUIREMENT

- STRUCTURE/CLOSED AIR LOOP ● SEALED ENCLOSURE
- STRUCTURE ● ISOLATION OF CABIN AIR FROM AVIONICS AND CLOSED AIR LOOPS
- CLOSED AIR LOOP ● ULTIMATE FACTORS OF SAFETY: 2.0 (QS), 1.4 (RV)
- ● TEMP RANGE: 20°C TO 30°C
 - ACCURACY: $\pm 1^\circ\text{C}$ AT INLET
- METHOD OF MOUNTING ● SELF-GENERATED LOADS AT $\text{EM} \leq 10^{-3}$ G IN 50 TO 2000 HZ RANGE
- POLAR ROTATOR ● SPOTLIGHT AZIMUTH IN RANGE 100° TO 130°
 - $\pm 180^\circ$ FURNACE ROTATION
 - RESOLUTION: $\pm 0.5^\circ$
- VIEWING PORT ● 2.5 IN. DIAMETER FOV ABOUT SOURCE MATERIAL
- OVERPRESSURE CHAMBER ● FURNACE OVERPRESSURE PROTECTION
- REDUNDANT SAFING THERMAL SWITCH ● TWO INDEPENDENT INHIBITS TO CATASTROPHIC FAILURE



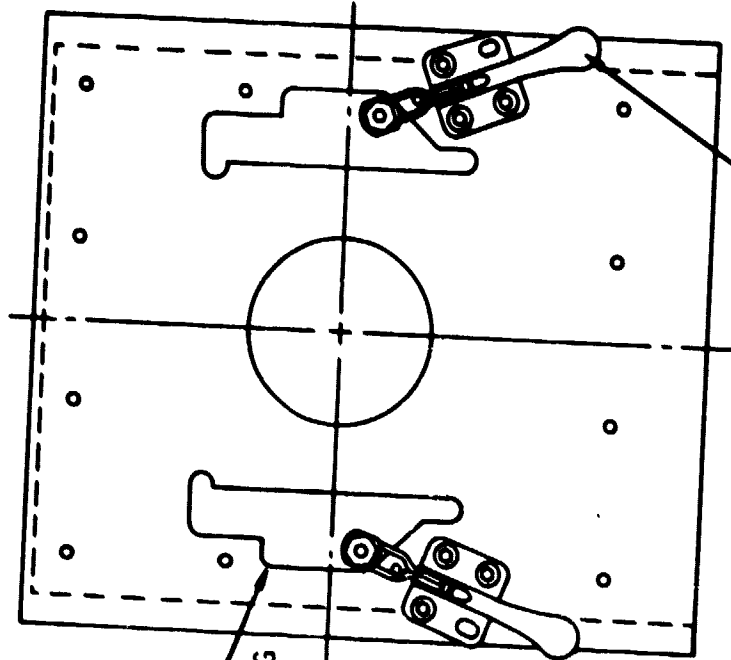
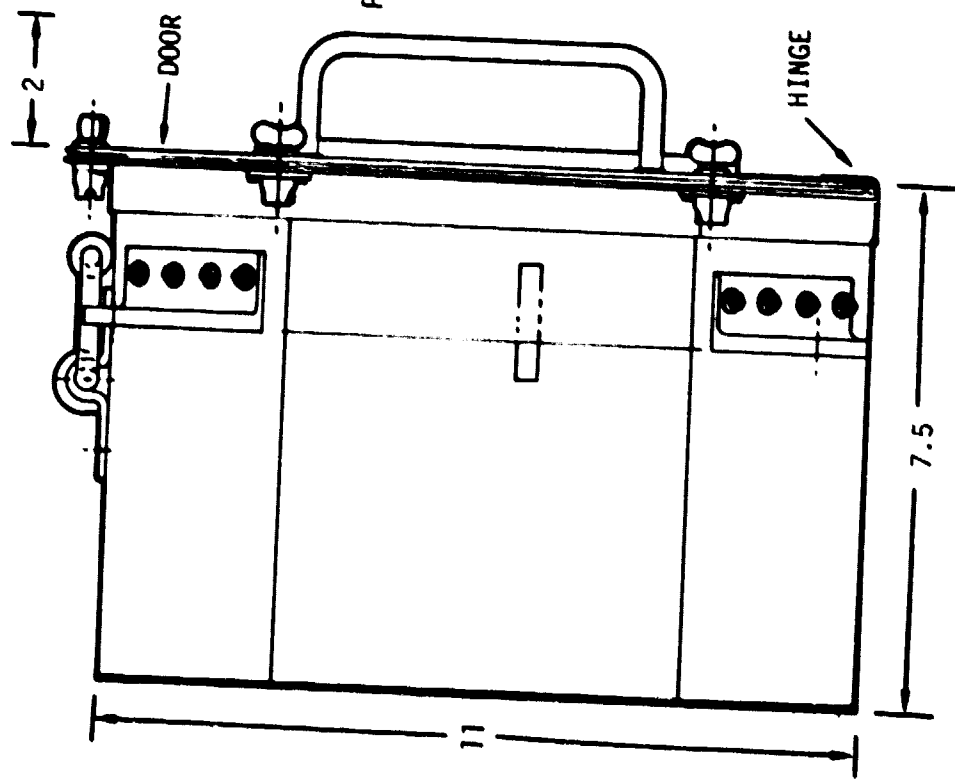
EXPERIMENT ENCLOSURE REQUIREMENTS/CAPABILITIES

<u>CAPABILITY</u>	<u>VERIFICATION METHOD</u>
● LEAKAGE: 0.01 SCCM HE, $\Delta P = 1.6 \times 10^{-5}$ N/M ²	● ANALYSIS/DESIGN
● PARTICULATES ≥ 10 MICRONS ARE FILTERED	
● SPEC CHANGE REQUESTED	● —
● PER REQUIREMENT	● ANALYSIS
● NOMINAL SETPOINT: $25 \pm 2^{\circ}\text{C}$	● ANALYSIS
○ ACCURACY: $\pm 0.6^{\circ}\text{C}$	
● PER REQUIREMENT	● ANALYSIS/DESIGN
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● DESIGN
● ΔP ACROSS FURNACE ENCLOSURE: 1.5 PSI MAX	● ANALYSIS
● REDUNDANT SAFING THERMAL SWITCH	● DESIGN



TRW/ASPO

STORAGE ENCLOSURE



TOGGLE CLAMP

POSITIONING RECESS



TRW/ASPO

STORAGE ENCLOSURE FEATURES/KEY COMPONENTS

- TWO-POSITION, SHOCK-ISOLATED MOUNTING PLATE
- FURNACE/AMPOULE UNIT MOUNTING PLATE
- PROTECTIVE COVER
- VIEWING PORT
- HANDLES/TOGGLE CLAMPS



STORAGE ENCLOSURE REQUIREMENTS/CAPABILITIES

DESIGN FEATURE

REQUIREMENT

- | | |
|-------------------------|--|
| ● METHOD OF MOUNTING | ● G-VECTOR NORMAL TO AMPOULE BASE $\pm 15^\circ$ |
| | ● PEAK ACCELERATION AT EN ≤ 20 G |
| ● STRUCTURE | ● ULTIMATE FACTORS OF SAFETY: 2.0 (QS), 1.4 (RV) |
| | ● CONTAINMENT OF HgI_2 PARTICULATES |
| | ● ENCLOSURE TEMP $-10^\circ C$ TO $55^\circ C$, RATE $\leq 25^\circ C/HR$ |
| ● PROTECTIVE COVER | ● PROVIDE THREE INDEPENDENTLY INHIBITS TO CATASTROPHIC FAILURES |
| ● HANDLES/TOGGLE CLAMPS | ● PAYLOAD SPECIALIST INTERFACE |



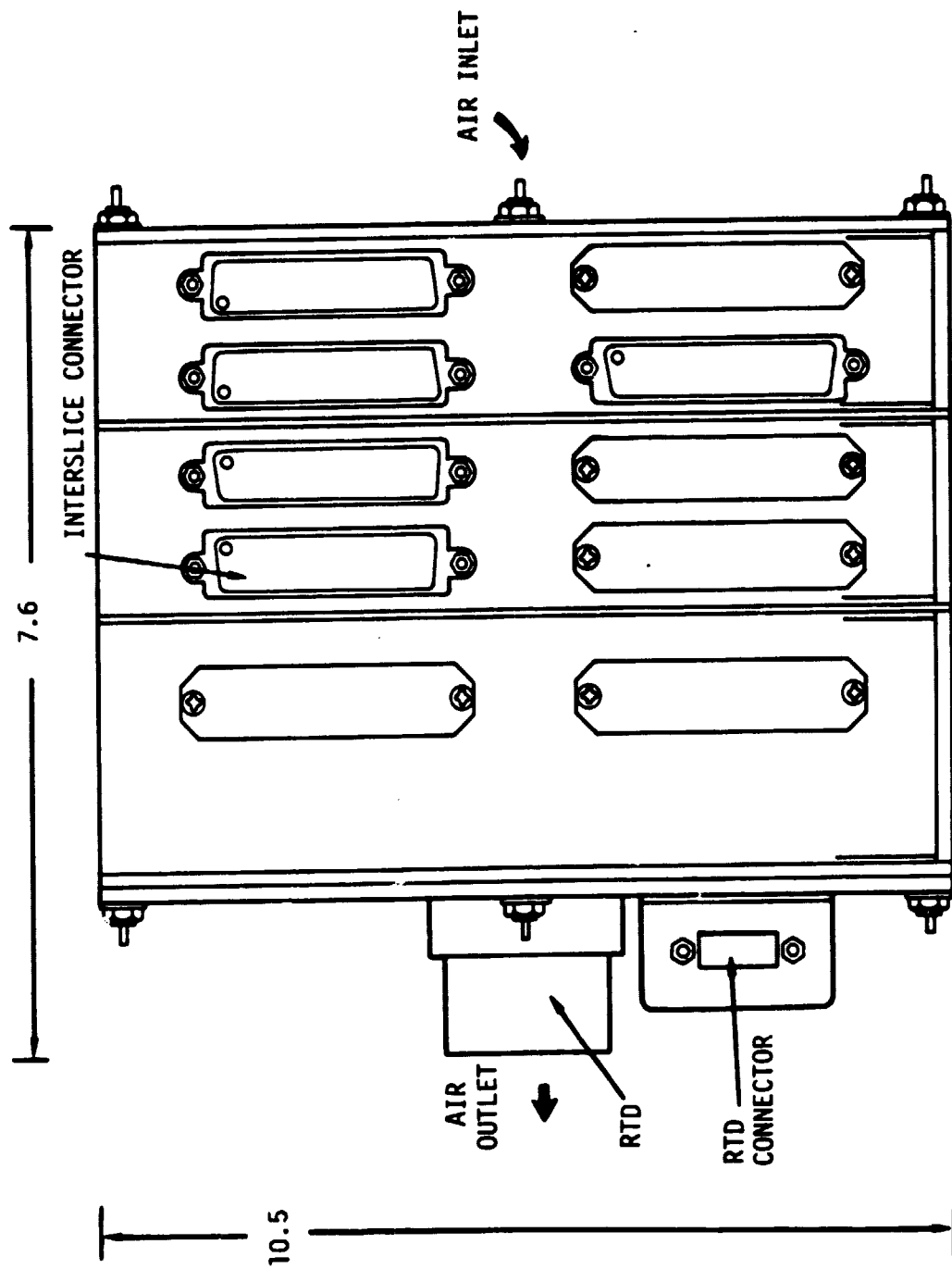
STORAGE ENCLOSURE REQUIREMENTS/CAPABILITIES

<u>CAPABILITY</u>	<u>VERIFICATION METHOD</u>
● 2-POSITION ALIGNMENT PER REQUIREMENT	● ANALYSIS/DESIGN
● PER REQUIREMENT	● ANALYSIS
● PER REQUIREMENT	● ANALYSIS
● CONTAINMENT OF PARTICULATES ≥ 10 MICRONS	● ANALYSIS
● SHIPPING CONTAINER (GROUND HANDLING)	● ANALYSIS
● AVIONICS AIR (ON-ORBIT)	● SL RESOURCE
● PER REQUIREMENT FROM STORAGE TO EXP ENCLOSURE	● DESIGN
● USE OF TWO HANDS AND STANDARD TOOLS	● DESIGN



TRW/ASPO

VCG ELECTRONICS UNIT



TRW/ASPO

ELECTRONICS UNIT FEATURES/KEY COMPONENTS

- TEMP SENSE *
- EXPERIMENT BUS INTERFACE *
- HEATER DRIVE *
- THERMOELECTRIC DRIVE *
- POWER SUPPLY **
- SAFING RELAYS **

* IDENTICAL TO CEU

** PIECE PARTS IDENTICAL TO PCU



TRW/ASPO

ELECTRONICS UNIT REQUIREMENTS/CAPABILITIES

DESIGN FEATURE

REQUIREMENT

- TEMP SENSE BOARD
 - INSTRUMENTATION FOR 8 RTDs
 - RANGE: AMBIENT TO 160°C
 - ALLOCATED ERRORS
 - ACCURACY $\leq \pm 0.8^{\circ}\text{C}$
 - STABILITY $\leq \pm 0.02^{\circ}\text{C}$
 - REPEATABILITY $\leq \pm 0.02^{\circ}\text{C}$
 - RESOLUTION $\leq \pm 0.01^{\circ}\text{C}$
- HEATER DRIVE BOARD
 - DRIVES FOR 4 HEATERS
 - POWER: 50 WATTS (EACH) MAX
 - VARIABLE VOLTAGE
- TE DRIVE BOARD
 - DRIVE FOR 1 TE
 - VARIABLE CURRENT
- SECONDARY POWER SUPPLY BOARD
 - +5V/3.3 AMP
 - +15V/0.2 AMP
 - +6V/3.3 AMP
 - +28V/0.4 AMP
 - -15V/0.2 AMP
- SAFING RELAYS
 - TWO INDEPENDENT RELAYS

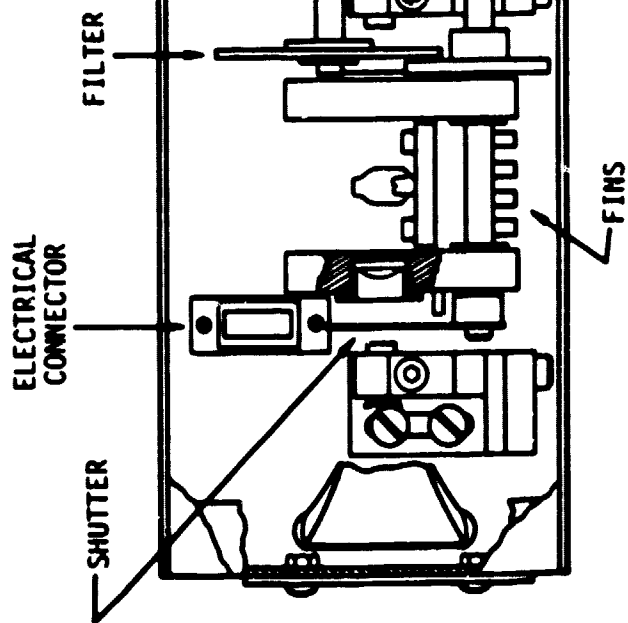
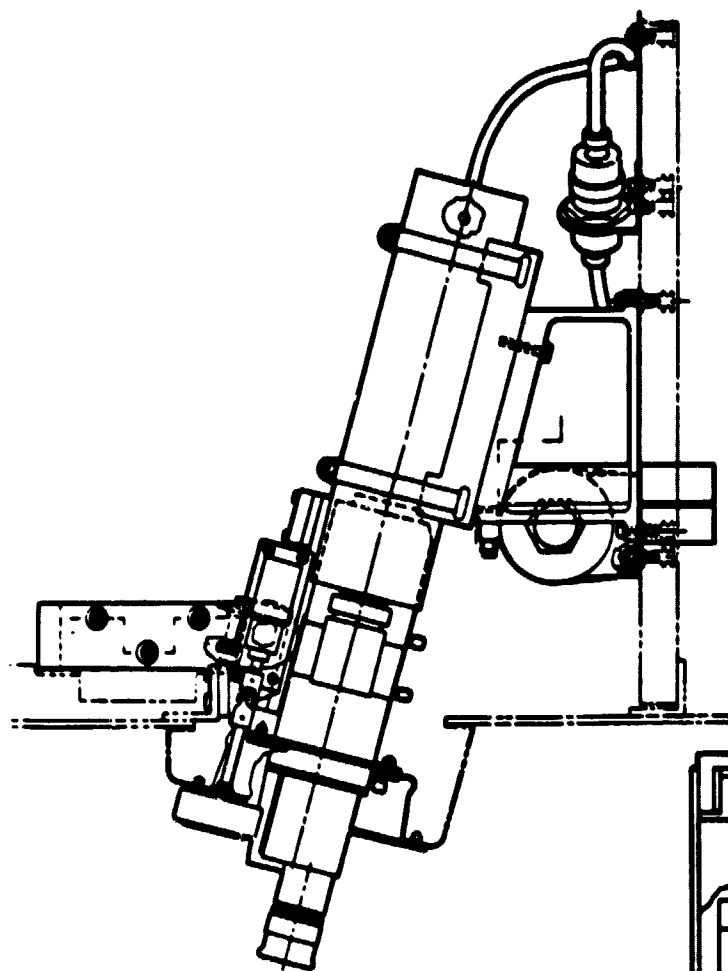


ELECTRONICS UNIT REQUIREMENTS/CAPABILITIES

CAPABILITY	VERIFICATION METHOD
● INSTRUMENTATION FOR 15 RTDs	● DESIGN
● RANGE: AMBIENT TO 200°C	● DESIGN
● TEMP SENSE ERRORS	● ANALYSIS/BB TESTS
○ ACCURACY $\leq \pm 0.6^{\circ}\text{C}$	
○ STABILITY $\leq \pm 0.02^{\circ}\text{C}$	
○ REPEATABILITY $\leq \pm 0.02^{\circ}\text{C}$	
○ RESOLUTION $\leq \pm 0.003^{\circ}\text{C}$	
● PER REQUIREMENT	● DESIGN
● PER REQUIREMENT	● ANALYSIS/BB TESTS
● 0-16 V IN 511 STEPS	● ANALYSIS/BB TESTS
● PER REQUIREMENT	● DESIGN
● 0-2 AMP IN 512 STEPS	● ANALYSIS/BB TESTS
● +5V/4.5 AMP	● ANALYSIS
● +15V/0.5 AMP	● ANALYSIS
● $\pm 5\text{V}/4.5\text{ AMP}$	● ANALYSIS
● +28V/1.0 AMP	● ANALYSIS
● -15V/0.5 AMP	● ANALYSIS
● PER REQUIREMENT	● DESIGN/ANALYSIS



OPTICAL ASSEMBLY UNIT



TRW/ASPO

OPTICAL ASSEMBLY FEATURES/KEY COMPONENTS

- ILLUMINATOR ASSEMBLY
 - LAMP
 - LENSES
 - OPTICAL FIBER BUNDLES
 - VARIABLE DENSITY FILTER
- MICROSCOPE
- VIDEO CAMERA



OPTICAL ASSEMBLY REQUIREMENTS/CAPABILITIES

DESIGN FEATURE

REQUIREMENT

- MICROSCOPE/VIDEO
 - PERFORMANCE OF ZEISS OPHI-6 MICROSCOPE/COHU NEWICON VIDEO OR EQUIVALENT
 - MAGNIFICATION: 10X TO 30X
 - CRYSTAL SIZE MEASUREMENT
 - VIEWING ELEVATION $15 \pm 3^\circ$ ABOVE AMPOULE BASE
- ILLUMINATOR ASSEMBLY
 - 50 FC BACKGROUND LIGHTING
 - 0-90 FC VARIABLE SPOTLIGHTING
 - NO DETECTABLE SPECTRAL COMPONENTS IN RANGE $< 3500 \text{ \AA}$
 - SPOTLIGHT ELEVATION ADJUSTABLE 20° TO 55°



OPTICAL ASSEMBLY REQUIREMENTS/CAPABILITIES

<u>CAPABILITY</u>	<u>VERIFICATION METHOD</u>
● PER REQUIREMENT	● DESIGN
● MAGNIFICATION: 5.3X TO 35X	● DESIGN/ANALYSIS
● RETICLE IN EYEPiece	● DESIGN
● PER REQUIREMENT	● DESIGN
● 80 FC MAX	● DESIGN/ BB TEST
● 140 FC MAX	● DESIGN/ BB TEST
● DETECTABLE (7.7 MICRO-W/SQ. IN.) (SPEC CHANGE REQUESTED)	● DESIGN/ANALYSIS
● ADJUSTABLE MIRROR PER REQUIREMENT	● DESIGN

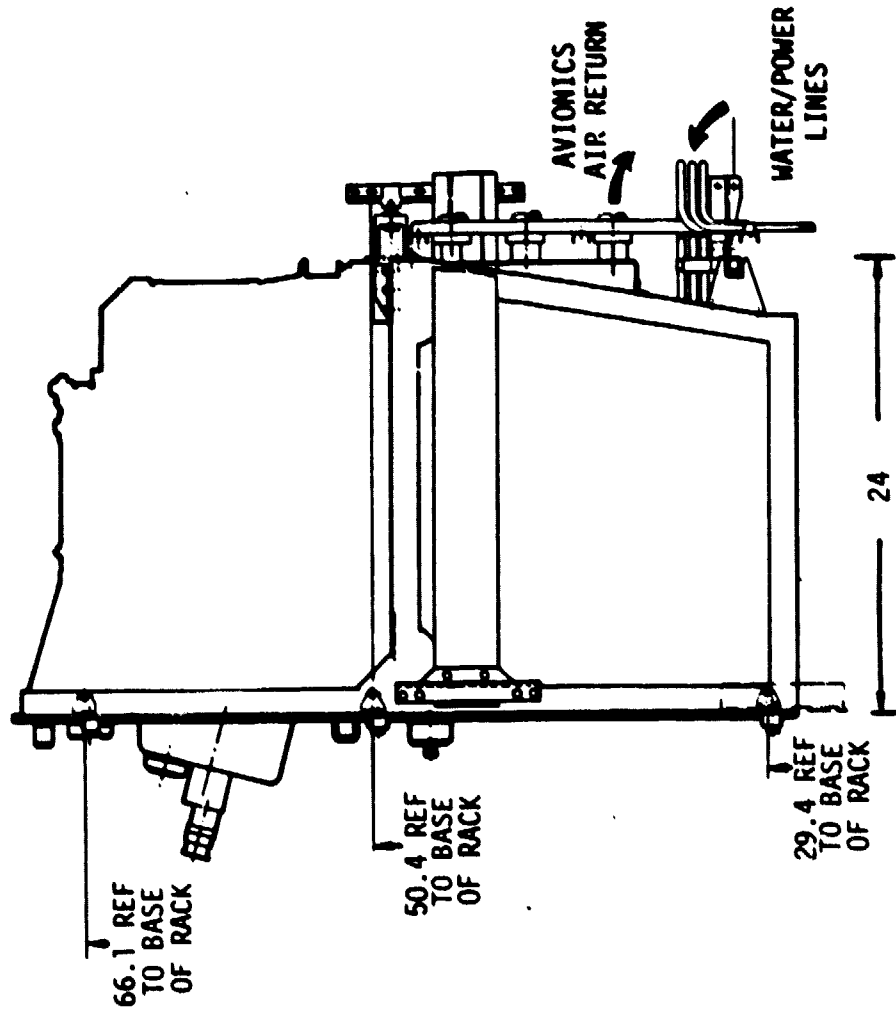
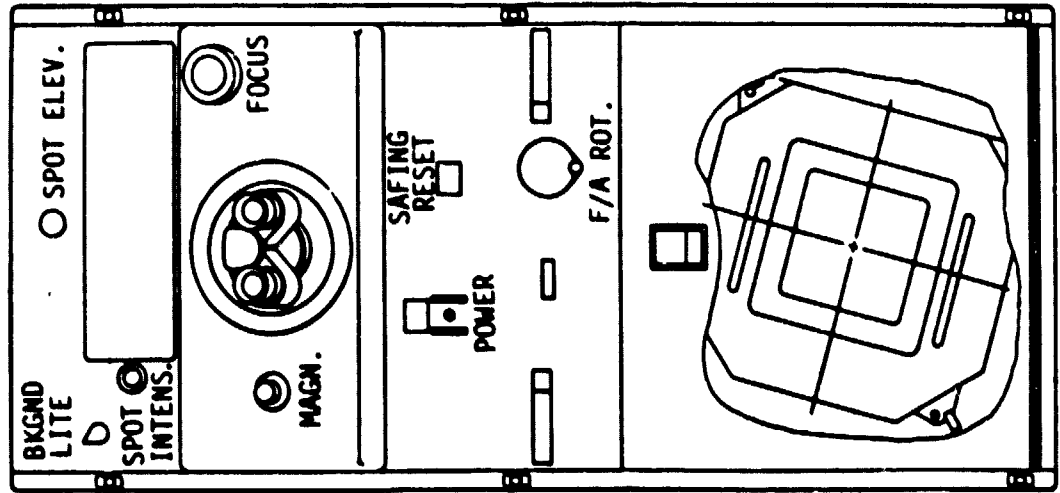


OPTICAL ASSEMBLY BREADBOARD TESTS

COMPONENT	TEST	RESULTS
VIEWING PORT	<ul style="list-style-type: none"> ● DETERMINE DEGRADATION IN MICROSCOPE VIEWING DUE TO LEXAN WINDOW 	<ul style="list-style-type: none"> ● NO OBSERVABLE DEGRADATION IN MICROSCOPE RESOLUTION DUE TO 1/8 I.I LEXAN (15° VIEWING ANGLE; AIR FORCE CHART)
MICROSCOPE CHARACTER- IZATION	<ul style="list-style-type: none"> ● MEASURE MAGNIFICATION RANGE ● CALIBRATE OCULAR RETICLE ● DETERMINE RESOLUTION 	<ul style="list-style-type: none"> ● FOR MAG SELECTOR 0.4 TO 2.5: <ul style="list-style-type: none"> ○ MEASURED MAG 5.3 X ± 0.3 TO 35X ± 1.0 ○ FOV 35 MM TO 5.3 MM ○ RETICLE 1.44 TO 0.22 HFV/DIV ● RESOLUTION = 102 LINES/MM
LAMP	<ul style="list-style-type: none"> ● INTENSITY MEASUREMENT PER PI SETUP ● RANDOM VIBRATION <ul style="list-style-type: none"> ○ NUMBER AXES: 3 ○ LEVEL: 20.9 GRMS ○ DURATION: 3 MIN/AXIS 	<ul style="list-style-type: none"> ● BACKGROUND: 80 FC MAX ● SPOTLIGHT: 140 FC MAX ● PASSED



EQUIPMENT DRAWER ASSEMBLY



TRW/ASPO

EQUIPMENT DRAWER FEATURES/KEY COMPONENTS

- STRUCTURE
- FRONT PANEL
 - OPERATOR CONTROLS
 - LIGHTING/MICROSCOPE ADJUSTMENTS
 - FURNACE ROTATION
 - POWER/SAFING RELAY RESET SWITCHES
 - VIEWING PORT *
- SL RACK INTERFACING HARDWARE
 - SLIDES
 - SHEAR PINS (REAR)
 - CAPTIVE SCREWS/TRIGGER LOCK LATCHES* (FRONT PANEL)
 - SELF-MATING AVIONICS AIR DUCT

* POST-PDR ADDITIONS



EQUIPMENT DRAWER REQUIREMENTS/CAPABILITIES

DESIGN FEATURE

REQUIREMENT

- FRONT PANEL MANUAL CONTROLS
 - ON/OFF BACKGROUND LIGHTING
 - 0-90 FC VARIABLE SPOTLIGHT
 - 20°-55° SPOTLIGHT ELEVATION ADJUSTMENT
 - MICROSCOPE MAGNIFICATION ADJUSTMENT
 - MICROSCOPE FOCUS ADJUSTMENT
 - $\pm 180^\circ$ FURNACE ROTATION
 - RESOLUTION: $\pm 0.5^\circ$
- FRONT PANEL WINDOW
- METHOD OF MOUNTING
- FRONT PANEL ELECTRICAL CONTROLS
 - 2.5 IN. DIAMETER FOV ABOUT SOURCE MATERIAL
 - MICROSCOPE ELEVATION $15 \pm 3^\circ$ (FIXED)
 - G-VECTOR NORMAL TO AMPOULE BASE $\pm 15^\circ$
 - POWER SWITCHING
- SAFING RELAY RESET
- STRUCTURE
 - ULTIMATE FACTORS OF SAFETY: 2.0 (QS), 1.4 (RV)
 - QUICK CLOSING DRAWER LATCHING



EQUIPMENT DRAWER REQUIREMENTS/CAPABILITIES

CAPABILITY	VERIFICATION METHOD
● ON/OFF CONTROL KNOB	● DESIGN
● PER REQUIREMENT WITH 300° KNOB ROTATION	● DESIGN
● PER REQUIREMENT (POSITIONABLE MIRROR)	● DESIGN
● FULL RANGE	● DESIGN
● FULL TRAVEL (± 0.81 IN.)	● DESIGN
● PER REQUIREMENT (MECHANICAL DIGITAL READOUT)	● DESIGN
○ RESOLUTION: $\pm 0.1^\circ$	
● PER REQUIREMENT	● DESIGN
● 2-POSITION ALIGNMENT OF STORAGE ENCLOSURE PER REQUIREMENT	● ANALYSIS/DESIGN
● CENTER LOCK MOMENTARY ON/OFF SWITCH	● DESIGN
○ "ON" INDICATOR LIGHT	
● RESET PUSHBUTTON SWITCH	● DESIGN
○ OPEN RELAY INDICATOR LIGHT	
● PER REQUIREMENT	● ANALYSIS
● TRIGGER-LOCK LATCHES	● DESIGN
○ 900 LBS ULTIMATE (EACH)	



SYSTEM PERFORMANCE REQUIREMENTS VERSUS CAPABILITIES

- ALL PERFORMANCE REQUIREMENTS ARE MET EXCEPT FOR:

FUNCTION	REQUIREMENT	RECOMMENDED SPEC CHANGE
STRUCTURE	<ul style="list-style-type: none"> ● SEALED EXP ENCLOSURE ● ISOLATION OF CABIN AIR FROM AVIONICS AND VCGS CLOSED AIR LOOPS 	<ul style="list-style-type: none"> ● ENCLOSURE LEAKAGE CONSISTENT WITH SAFETY REQUIREMENT ● DELETE
VIEWING/ IMAGING	<ul style="list-style-type: none"> ● NO DETECTABLE SPECTRAL COMPONENTS IN RANGE < 3500 Å (SPOT BACKGROUND LIGHTING 	<ul style="list-style-type: none"> ● DETECTABLE SPECTRAL COMPONENTS IN RANGE < 10 MICRO-W/CM²
TEMP CONTROL/ SOFTWARE	<ul style="list-style-type: none"> ● SOURCE MODULATION PERIOD (T) AND HEATING PORTION (T_H) ACCURATE TO ± 2.5 PERCENT ● IN REACHING MODULATION LIMIT, BOTH TIME AND TEMP LIMIT APPLY (SOURCE MODULATION) ● AFTER HEATUP, CONDITIONS FOR GROWTH ARE STABILIZED 	<ul style="list-style-type: none"> ● ACCURACY ≤ ±2.5 PERCENT FOR 40 SEC ≤ T; 40 SEC ≤ T_H ● ACCURACY = ±1 SEC FOR 40 SEC > T; 40 SEC > T_H ● ONLY TIME GOVERNS SOURCE MODULATION
C4-341		<ul style="list-style-type: none"> ● NO STABILIZATION TIME SEGMENT IN TIMELINE (PI REQUEST)



TRW/ASPO

**FES/VCGS PRODUCT ASSURANCE
CDR OVERVIEW**



TRW/ASPO

PRODUCT ASSURANCE OVERVIEW

- QUALITY ASSURANCE
- RELIABILITY ENGINEERING
- SAFETY ENGINEERING
- MATERIALS & PROCESSES
- PARTS ENGINEERING



QUALITY ASSURANCE

STATUS AT CDR:

- QUALITY ASSURANCE PLAN, DOCUMENT NO 318763,
APPROVED BY MSFC
- NO KNOWN OPEN ITEMS



RELIABILITY ENGINEERING

STATUS AT CDR:

- FMEA/CIL, DOCUMENT NO D02895, UPDATED
FROM PDR AND RESUBMITTED AT CDR



TRW/ASPO

RELIABILITY ENGINEERING

FAILURE MODES AND EFFECTS ANALYSES (FMEA'S)

- PERFORMED AT COMPONENT (UNIT) LEVEL.
 - DETERMINE FAILURE MODES FOR EACH COMPONENT OUTPUT
 - DETERMINE EFFECT EACH FAILURE MODE UPON:
 - EXPERIMENTS
 - SPACELAB INTERFACES
 - DETERMINE CRITICALITY CATEGORY EACH FAILURE MODE
 - 1 SINGLE FAILURE POINT RESULTS IN LOSS OF LIFE OR VEHICLE
 - 1R FAILURE ALL REDUNDANT ELEMENTS LEADS TO CATEGORY 1 EFFECTS
 - 2 SINGLE FAILURE POINT RESULTS IN MISSION ABORT
 - 2R FAILURE ALL REDUNDANT ELEMENTS RESULTS IN MISSION ABORT
 - 3A SINGLE FAILURE POINT RESULTS IN LOSS OF PAYLOAD SYSTEMS COMPLEMENT
 - 3B SINGLE FAILURE POINT RESULTS IN LOSS OF AT LEAST 50 PERCENT OF MPS/SL COMPLEMENT
 - 3C ALL OTHERS



TRW/ASPO

RELIABILITY ENGINEERING

EMEA/CIL SUMMARY: TOTAL NO. OF FAILURE MODES EVALUATED = 183

	FES	FES/VCG	VCG
● TOTAL UNITS	8		5
● SHARED UNITS		4	
● TOTAL FAILURE MODES EVALUATED	117	33	33
● CRITICALITY 1, 1R	0	0	0
2, 2R	0	0	0
3A	11	22	1
3B	44	3	18
3C	112	8	14

● CRITICAL ITEMS:

AN ITEM WITH FAILURE MODE 1,1R,2,2R,3A OR 3B



RELIABILITY ENGINEERING

RATIONALE FOR RETENTION OF 3A/3B ITEMS:

- EACH CRITICAL ITEM CATEGORY 3A/3B HAVE SPECIFIC JUSTIFICATION FOR RETENTION CLEARLY STATED IN THE CIL.
- GENERAL RATIONALIZATION:
 - DESIGN CHARACTERISTICS
 - SPECIAL TESTING (DEVELOPMENT, QUAL, ACCEPTANCE)
 - SPECIAL INSPECTION INSTRUCTIONS
 - FAILURE HISTORY CHARACTERISTICS
 - USE OF APPROVED PARTS
 - PART DERATING
 - USE ENVIRONMENT
 - MATERIAL & PROCESSES SCREENING



TRON/ASPO

SAFETY ENGINEERING

STATUS AT CDR:

- SCDP (SAFETY COMPLIANCE DATA PACKAGE), DOCUMENT NO 914395, HAS BEEN UPDATED FROM PDR AND RESUBMITTED AT CDR. (STEP 3)
- IN FULL COMPLIANCE WITH NHB 1700.7 SAFETY POLICY AND REQUIREMENTS FOR PAYLOADS USING THE SPACE TRANSPORTATION SYSTEM.



TRW/ASPO

SAFETY ENGINEERING

CATASTROPHIC HAZARD

- RESULTS IN PERSONNEL INJURY, LOSS OF LIFE, OR PREVENTS THE SAFE RETURN TO EARTH OF THE ORBITER VEHICLE

CONTROL REQUIREMENTS

- 3 INDEPENDENT INHIBITS
- INHIBITS MAY BE MONITORED BY ORBITER FLIGHT CREW
- HAZARD MAY BE RETURNED TO SAFE CONDITION BY CREW

CRITICAL HAZARD

- RESULTS IN DAMAGE TO EQUIPMENT, OR THE USE OF CONTINGENCY OR EMERGENCY PROCEDURES

CONTROL REQUIREMENTS

- 2 INDEPENDENT INHIBITS
- INHIBITS MAY BE MONITORED BY ORBITER FLIGHT CREW
- HAZARD MAY BE RETURNED TO SAFE CONDITION BY CREW

C5-9



TRW/ASPO

SAFETY ENGINEERING

CATASTROPHIC HAZARDS

- ALL POTENTIAL CATASTROPHIC HAZARDS HAVE BEEN SAFED AND CAPABILITY FOR THE ORBITER CREW TO MONITOR EACH INHIBIT HAS BEEN PROVIDED.

CRITICAL HAZARDS

- NONE

NOTE: NO ADDITIONAL CATASTROPHIC SAFETY HAZARDS HAVE BEEN IDENTIFIED SINCE PDR.



TRW/ASPO

SAFETY ENGINEERING

FES: "SAFED" CATASTROPHIC HAZARDS

HAZARD

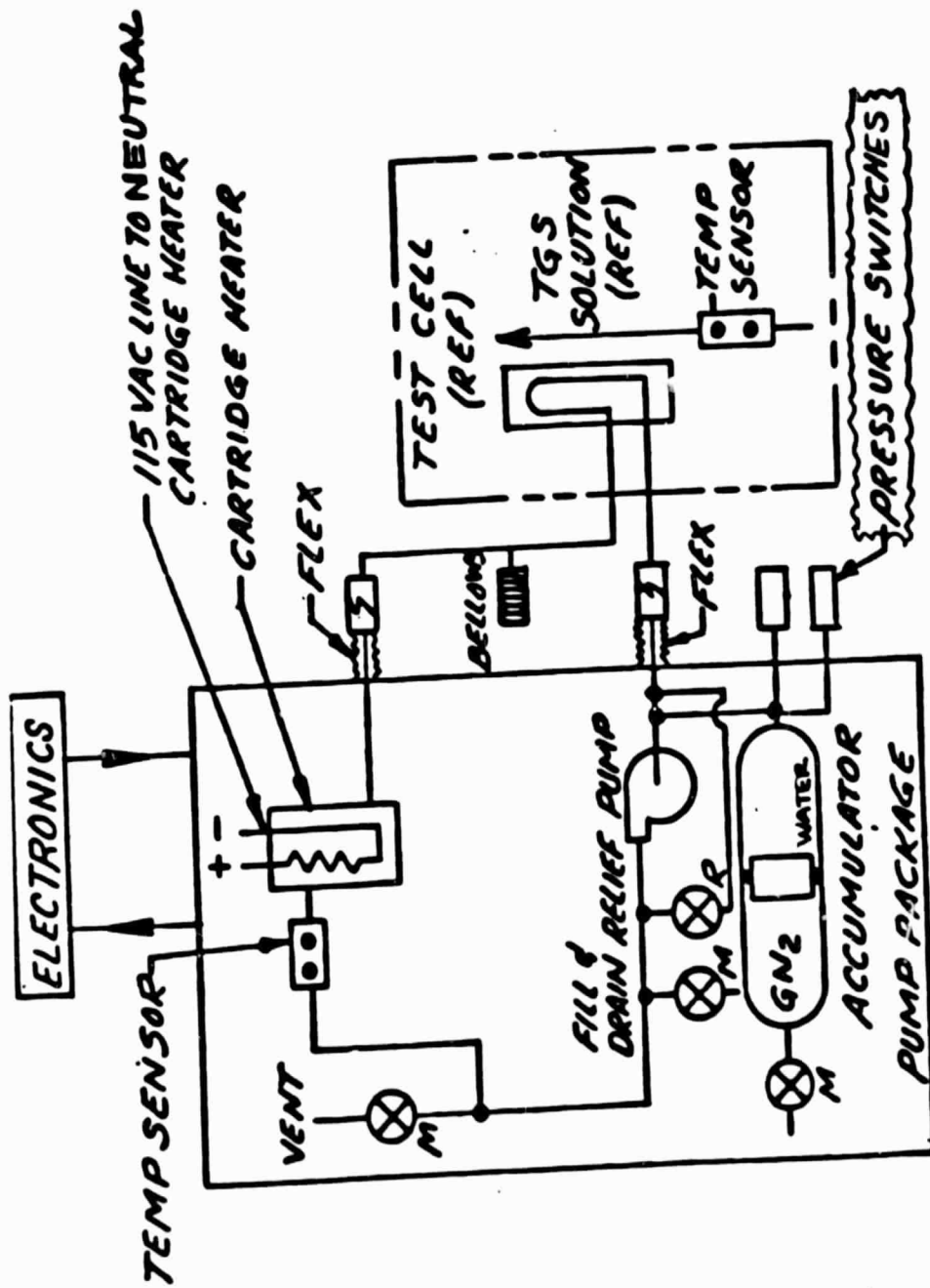
HOW SAFED

- | | |
|--|---|
| <p>①. FES TEST CELL HEATER RUN-AWAY WHILE IN</p> <ul style="list-style-type: none">● PREHEAT ENCLOSURE (PHR FES-4B-1)● EXPERIMENT ENCLOSURE (PHR FES-4B-2) | <p>①. 1st INHIBIT IS HEATER CONTROL CIRCUIT 2ND AND 3RD INHIBIT ARE 2 INDEPENDENT OVER <u>PRESSURE</u> SENSING SWITCHES WHEN ACTIVATED CAUSES SAFING RELAY TO OPEN WHICH CUTS POWER TO HEATER DRIVER.</p> |
| <p>②. FES WATER LOOP HEATER RUN-AWAY WHILE IN</p> <ul style="list-style-type: none">● PREHEAT ENCLOSURE (PHR FES-4J-3)● EXPERIMENT ENCLOSURE (PHR FES-4J-4) | <p>②. (SAME AS ABOVE)</p> |



SAFETY ENGINEERING

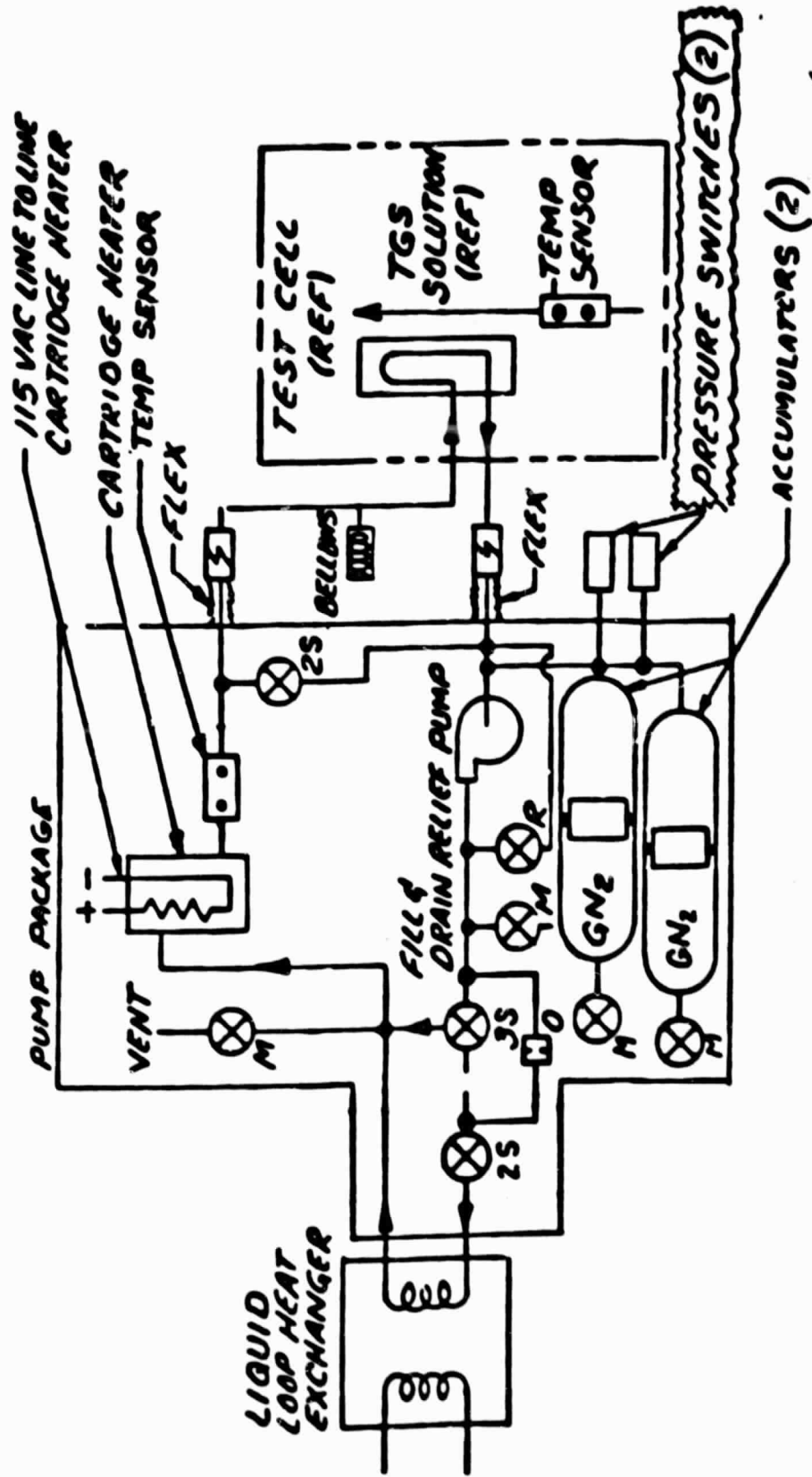
PHR FES-4B-1 (PREHEAT ENCLOSURE)



TRW/ASPO

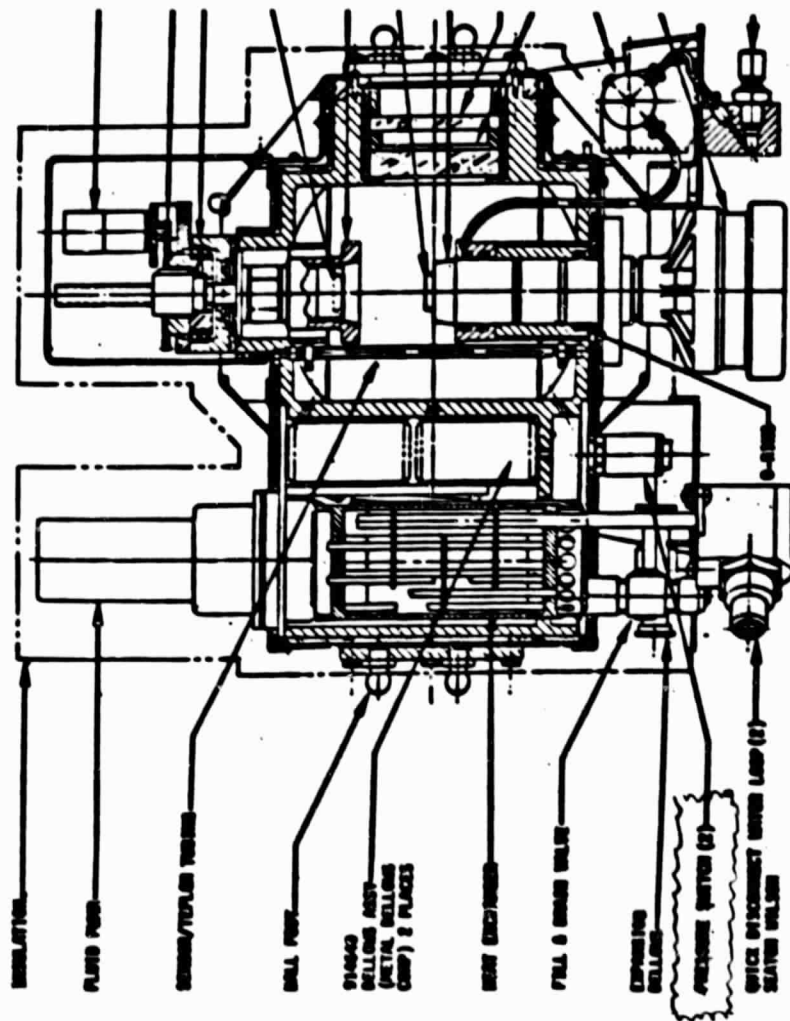
SAFETY ENGINEERING

PHR FES-4B-2 (EXPERIMENT ENCLOSURE)



SAFETY ENGINEERING

PHR FES-4B-1 CELL IN PREHEAT ENCLOSURE
 PHR FES-4B-2 CELL IN EXPERIMENT ENCLOSURE



SAFETY ENGINEERING

VCGS "SAFED" CATASTROPHIC HAZARDS

1. AIR LOOP RUN-AWAY TRIM HEATER
CAUSING TEMPERATURE EXTREMES
AND OFFGASSING (PHR VCG-4J-2)

1. 1st INHIBIT IS HEATER OPERATING CIRCUITRY
2ND AND 3RD INHIBIT ARE 2 INDEPENDENT
THERMAL SWITCHES WHICH REMOVE POWER TO
SAFING RELAYS WHICH IN TURN SHUT OFF
HEATER DRIVER.

2. EQUIPMENT DRAWER BEING EXTENDED
DURING EMERGENCY LANDING WOULD
BREAK LOOSE AND BECOME A PROJECTILE.
(PHR VCG-9A-2)

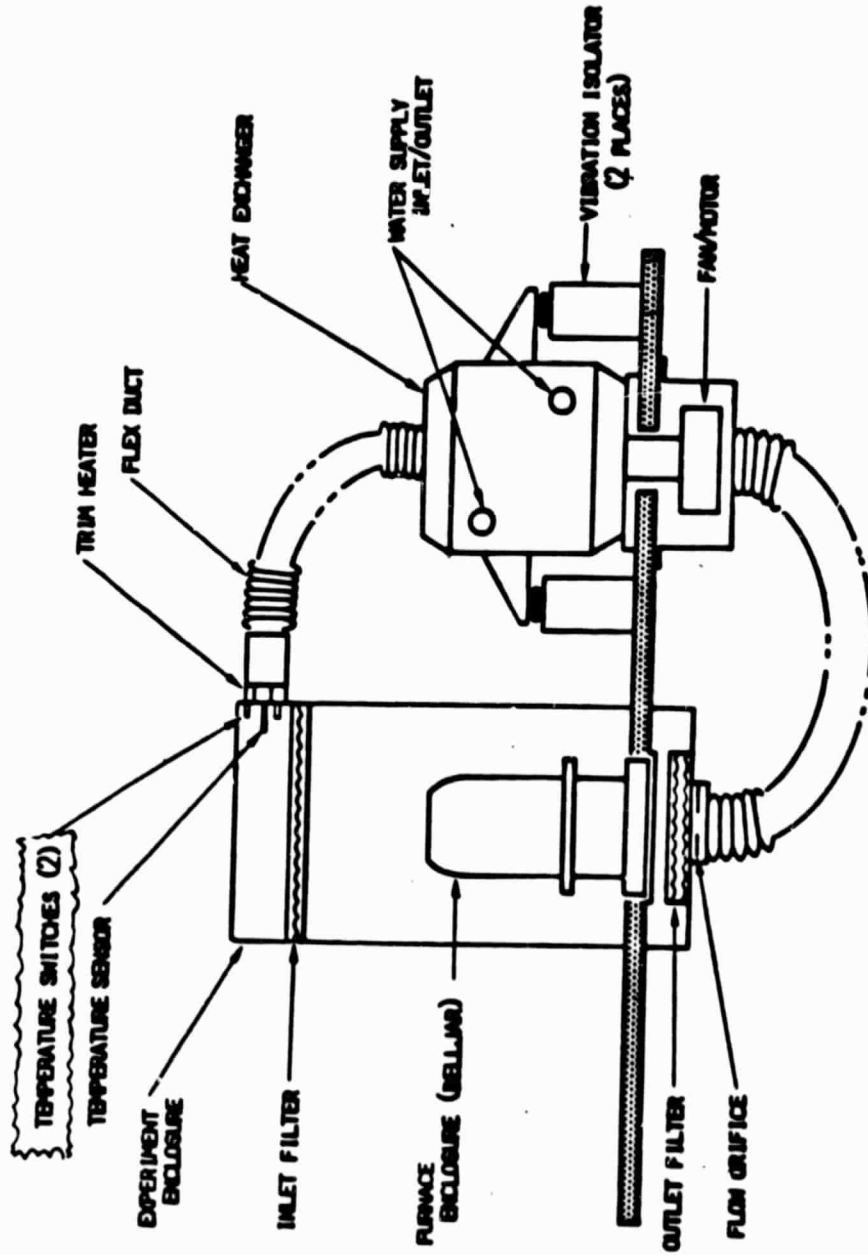
2. A QUICK-LATCH-AND-LOCK MECHANISM HAS
BEEN ADDED TO THE DESIGN.



TRW/ASPO

SAFETY ENGINEERING

PHR VCG-4J-2



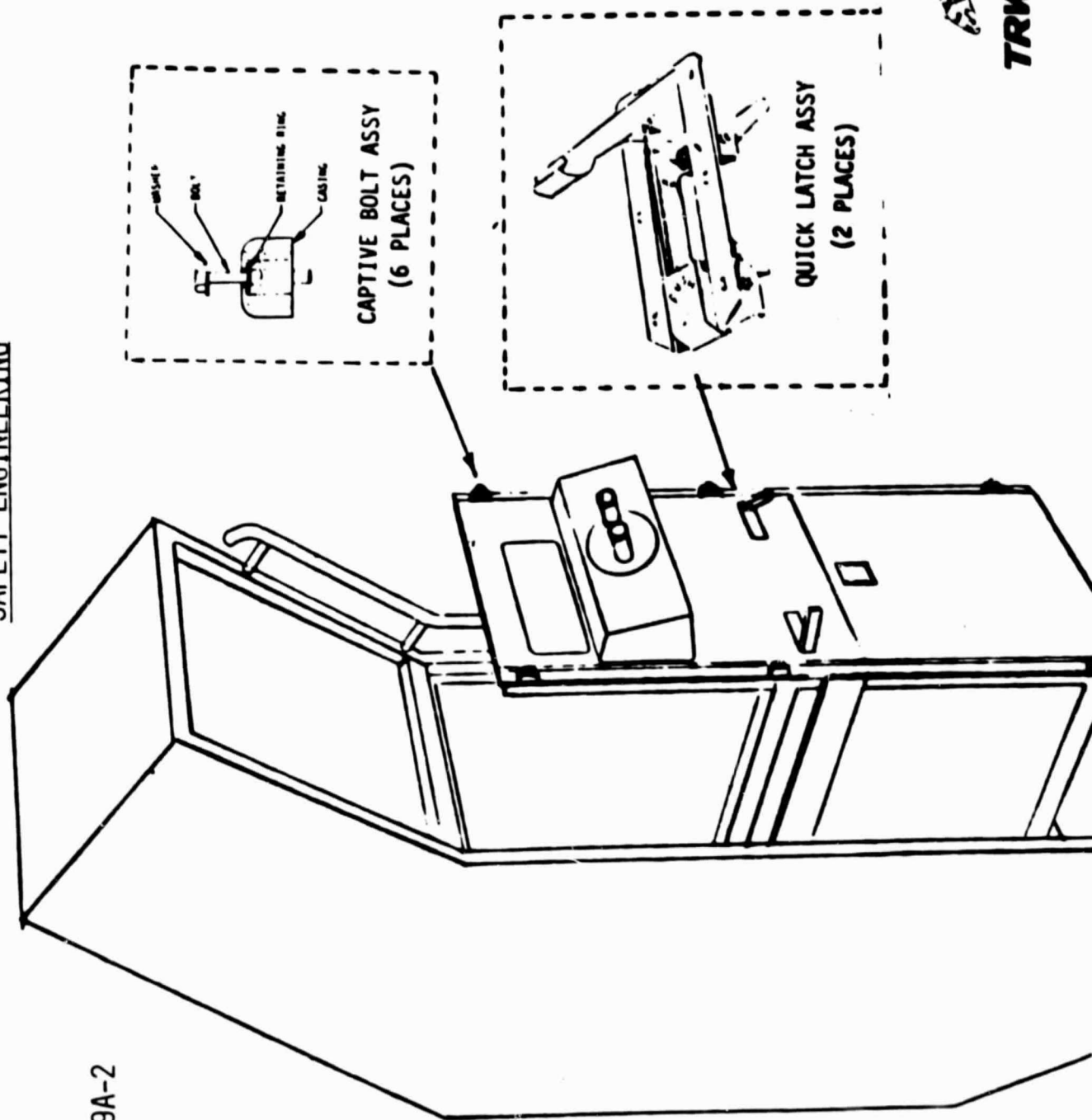
VOSS CLOSED LOOP AIR CONDITIONING



TRW/ASPO

SAFETY ENGINEERING

PHR VCG-9A-2



C5-17

TRW/ASPO

MATERIALS & PROCESSES

STATUS AT CDR:

- M & P PLAN D02483 UPDATED PER MSFC PDR RECOMMENDATIONS AND IS NOW APPROVED.
- "MULs" (MATERIAL UTILIZATION LISTS) PRESENTED IN CDR PACKAGE

NOTE: A COMPUTERIZED VERSION IS BEING DEVELOPED
AND HOPE TO HAVE IT ON-LINE IN 6 WEEKS.

- "MUAs" (MATERIAL UTILIZATION AGREEMENTS) ARE SUBMITTED TO MSFC FOR APPROVAL OF NON "A" RATED MATERIALS.
- OFF-THE-SHELF HARDWARE ITEMS ARE ALSO SUBMITTED FOR MSFC APPROVAL.
- COPIES OF ALL TRW M & P SPECIFICATIONS USED ON MPS HAVE BEEN PROVIDED.
- LIMITED LIFE ITEMS LIST AND CONTROLS DOCUMENT NO. D02885A UPDATED FROM PDR AND SUBMITTED IN CDR PACKAGE.



MATERIALS & PROCESSES

STATUS AT CDR (CON'T)

- CONTAMINATION CONTROL PLAN DOCUMENT NO D03279 SUBMITTED AS PART OF THE CDR PACKAGE.

- CLEANING AND CONTAMINATION CONTROL REQUIREMENTS PROCEDURE DOCUMENT
NO YJ-16P-01 SUBMITTED AS PART OF THE CDR PACKAGE.

- NO MAJOR M & P PROBLEMS PRESENTLY IDENTIFIED.

- 5 RIDS FROM PDR ARE OPEN. EXPECTED COMPLETION DATE IS 10/30/80.

- "MUA" STATUS

- 12 INITIATED
- 11 APPROVED
- 10 IN WORK



TRW/ASPO

PARTS ENGINEERING

STATUS AT CDR:

- PAPL (PROJECT APPROVED PARTS LIST) DOCUMENT NO D02613 HAS BEEN UPDATED, REVIEWED AND APPROVED BY MSFC.
- NON-STANDARD PARTS SELECTION AND SCREEN PLAN NO 319337 SUBMITTED WITH CDR PACKAGE.
- PARTS SUBSTITUTION LIST NO D03063 SUBMITTED WITH CDR PACKAGE.
- EEE PARTS DERATING REQUIREMENTS DOCUMENT NO 319338 SUBMITTED WITH CDR PACKAGE.
- ALL EEE PARTS ARE REVIEWED BY TRW & MSFC FOR DERATING COMPLIANCE.



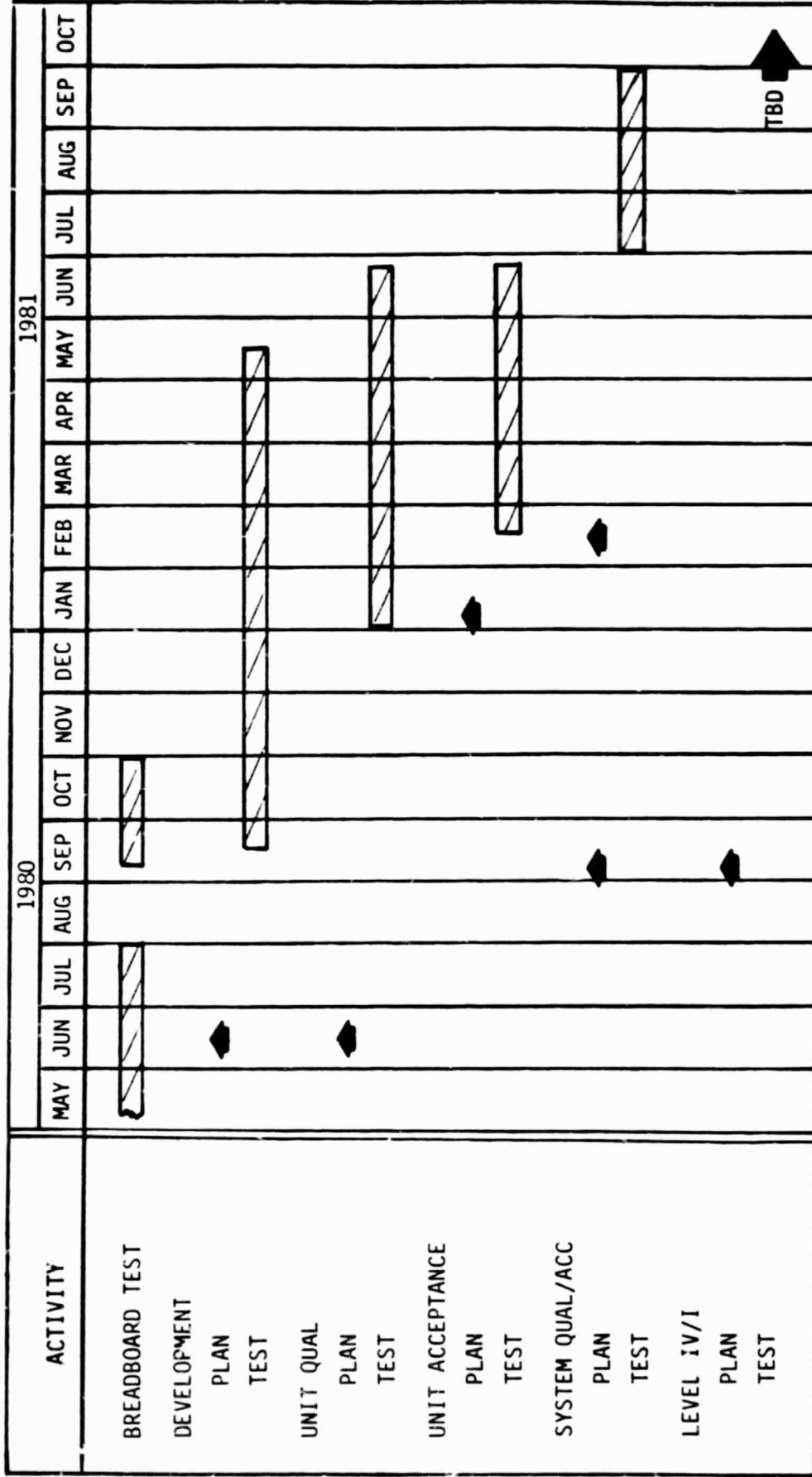
VERIFICATION OVERVIEW

- VERIFICATION SCHEDULE
- BREADBOARD TESTS
- DEVELOPMENT TESTS
- UNIT QUALIFICATION TESTS
- UNIT QUAL BY SIMILARITY
- SYSTEM QUAL/ACCEPTANCE
- LEVEL IV/III/II/I TESTS



TRW/ASPO

VERIFICATION SCHEDULE



TRW/ASPO

ELECTRONIC BREADBOARD TESTING

(UNIT DOCUMENT)

UNIT	TEST
<ul style="list-style-type: none"> • ELECTRONIC CIRCUITS <ul style="list-style-type: none"> • TEMP SENSE • HEATER LOGIC • STEP MOTOR DRIVE • RELAY LOGIC • BUS INTERFACE • A/D CONVERTER • HEATER DRIVE • T.E. DRIVE • ACCELEROMETER I/F • CAMERA I/F • BUS CONVERTER 	<ul style="list-style-type: none"> • CIRCUIT FUNCTIONS
<ul style="list-style-type: none"> • OPERATOR CONTROL PANEL 	<ul style="list-style-type: none"> • CIRCUIT AND DISPLAY FUNCTIONS
<ul style="list-style-type: none"> • ELECTRONICS UNIT MECHANICAL SLICE 	<ul style="list-style-type: none"> • COOLING AIR PRESSURE DROP
<ul style="list-style-type: none"> • STEPPER MOTORS 	<ul style="list-style-type: none"> • MOTOR CONTROL AND TORQUE
<ul style="list-style-type: none"> • A1 9551 USART PART 	<ul style="list-style-type: none"> • RESET CHARACTERISTICS
<ul style="list-style-type: none"> • TV MONITOR 	<ul style="list-style-type: none"> • VIBRATION INTEGRITY



MECHANICAL BREADBOARD TESTING
(UNIT DOCUMENT)

UNIT	TEST
● FES BENCH OPTICS AND LASER	● OPTICS AND HOLOGRAPHIC CHARACTERISTICS AND MARGINS
● FES THERMAL TEST CELL	● THERMAL CHARACTERIZATION, OPEN AND CLOSED LOOP CONTROL
● FES CELL STING	● CHARACTERIZATION AND OPEN LOOP CONTROL
● FES LASER	● VIBRATION INTEGRITY
● FES VACUUM PUMP AND PLATEN	● FILM PULL-DOWN CHARACTERISTICS
● FES QUICK DISCONNECT	● TORQUE AND PULL FORCE
● FES CELL MATERIALS	● TGS COMPATIBILITY
● FES STING CAP AND BLADDER	● EXPULSION CHARACTERISTICS
● FES BUBBLE TEST CELL	● BUBBLE GENERATION POTENTIAL



MECHANICAL BREADBOARD TESTING - (CONT'D)
(UNIT DOCUMENT)

UNIT	TEST
<ul style="list-style-type: none"> ● VCGS AMPOULE ● VCGS FURNACE/AMPOULE ● VCGS LIGHT ● VCGS AMPOULE/FURNACE ENCLOSURE 	<ul style="list-style-type: none"> ● VIBRATION INTEGRITY ● THERMAL CHARACTERIZATION ● OUTPUT AND VIBRATION INTEGRITY ● BREAKAGE CASCADE SAFETY



DEVELOPMENT TESTING
(D03269)

UNIT	TEST
<ul style="list-style-type: none"> FES STING 	<ul style="list-style-type: none"> OPEN LOOP THERMAL PERFORMANCE
<ul style="list-style-type: none"> FES CELL/STING/CEU/PCDA 	<ul style="list-style-type: none"> OPEN AND CLOSED LOOP THERMAL PERFORMANCE CELL FILL PROCEDURE AND LEAK CHECKS
<ul style="list-style-type: none"> EACH ELECTRONIC BOARD TYPE (12 TOTAL) 	<ul style="list-style-type: none"> FUNCTIONAL PERFORMANCE
<ul style="list-style-type: none"> FES FILM TRANSPORT, KNIFE EDGE ACTUATOR AND TV CAMERA/FOCUS LENS ASSEMBLY 	<ul style="list-style-type: none"> VIBRATION INTEGRITY
<ul style="list-style-type: none"> FES CAP VACUUM PUMP 	<ul style="list-style-type: none"> VIBRATION INTEGRITY



TRW/ASPO

UNIT QUALIFICATION TESTING

(D03268)

UNIT	TEST
<ul style="list-style-type: none"> CELL ELECTRONICS UNIT, POWER CONTROL UNIT AND VARIAC UNIT 	<ul style="list-style-type: none"> RANDOM VIBRATION, THERMAL CYCLING AND FUNCTIONAL ACCEPTANCE
<ul style="list-style-type: none"> FES OPTICAL ASSEMBLY WITHIN EXPERIMENT ENCLOSURE 	<ul style="list-style-type: none"> RANDOM VIBRATION, LEAK AND FUNCTIONAL ACCEPTANCE
<ul style="list-style-type: none"> FES TEST CELL WITHIN STORAGE ENCLOSURE 	<ul style="list-style-type: none"> RANDOM VIBRATION, LEAK AND FUNCTIONAL ACCEPTANCE
<ul style="list-style-type: none"> VCGS AMPOULE LOT SAMPLES 	<ul style="list-style-type: none"> PRESSURE AND TEMPERATURE
<ul style="list-style-type: none"> VCGS FURNACE ENCLOSURE 	<ul style="list-style-type: none"> PRESSURE AND TEMPERATURE
<ul style="list-style-type: none"> VCGS FURNACE/AMPOULE WITHIN STORAGE ENCLOSURE 	<ul style="list-style-type: none"> RANDOM VIBRATION, LEAK AND FUNCTIONAL ACCEPTANCE
<ul style="list-style-type: none"> VCGS MICROSCOPE 	<ul style="list-style-type: none"> RANDOM VIBRATION AND FUNCTIONAL ACCEPTANCE



TRW/ASPO

UNIT QUALIFICATION BY SIMILARITY

(D03268)

UNIT	TEST
<ul style="list-style-type: none"> PROCESS CONTROL AND DATA ACQUISITION UNIT (PCDA) 	<ul style="list-style-type: none"> SHUTTLE FLEXIBLE MULTIPLEXER/ DEMULTIPLEXER (FMDM)
<ul style="list-style-type: none"> ACCELEROMETER 	<ul style="list-style-type: none"> BELL MESA ACCELEROMETER
<ul style="list-style-type: none"> VCGS TV CAMERA 	<ul style="list-style-type: none"> FES TV CAMERA (OPTICAL ASSEMBLY)
<ul style="list-style-type: none"> PREHEAT PUMP PACKAGE 	<ul style="list-style-type: none"> EXPERIMENT ENCLOSURE PUMP PACKAGE
<ul style="list-style-type: none"> PREHEAT ELECTRONICS UNIT, BENCH ELECTRONICS UNIT AND VCGS ELECTRONICS UNIT 	<ul style="list-style-type: none"> CELL ELECTRONICS UNIT AND POWER CONTROL UNIT



TRW/ASPO

UNIT ACCEPTANCE

(319810)

UNIT	TEST
<ul style="list-style-type: none"> ● PREHEAT ENCLOSURE AND PUMP PACKAGE ● VCGS TV CAMERA ● PCDA ● ACCELEROMETER ● VCG ELECTRONICS ● BENCH ELECTRONICS ● PREHEAT ELECTRONICS ● CELL ELECTRONICS ● OPERATOR CONTROL PANEL ● HARNESS ● FES TEST CELL ● GAS/VACUUM ● VCG AMPOULES 	<ul style="list-style-type: none"> ● <div> FUNTIONAL TEST LEAK TEST PROOF PRESSURE TEST VIBRATION TEST THERMAL CYCLING PHYSICAL EXAMINATION </div> <div> AS APPROPRIATE PER SECTION 3.3 </div>
<ul style="list-style-type: none"> ● "UNIT-QUAL" UNITS 	<ul style="list-style-type: none"> ● POST QUAL TEST FUNCTIONAL



TRW/ASPO

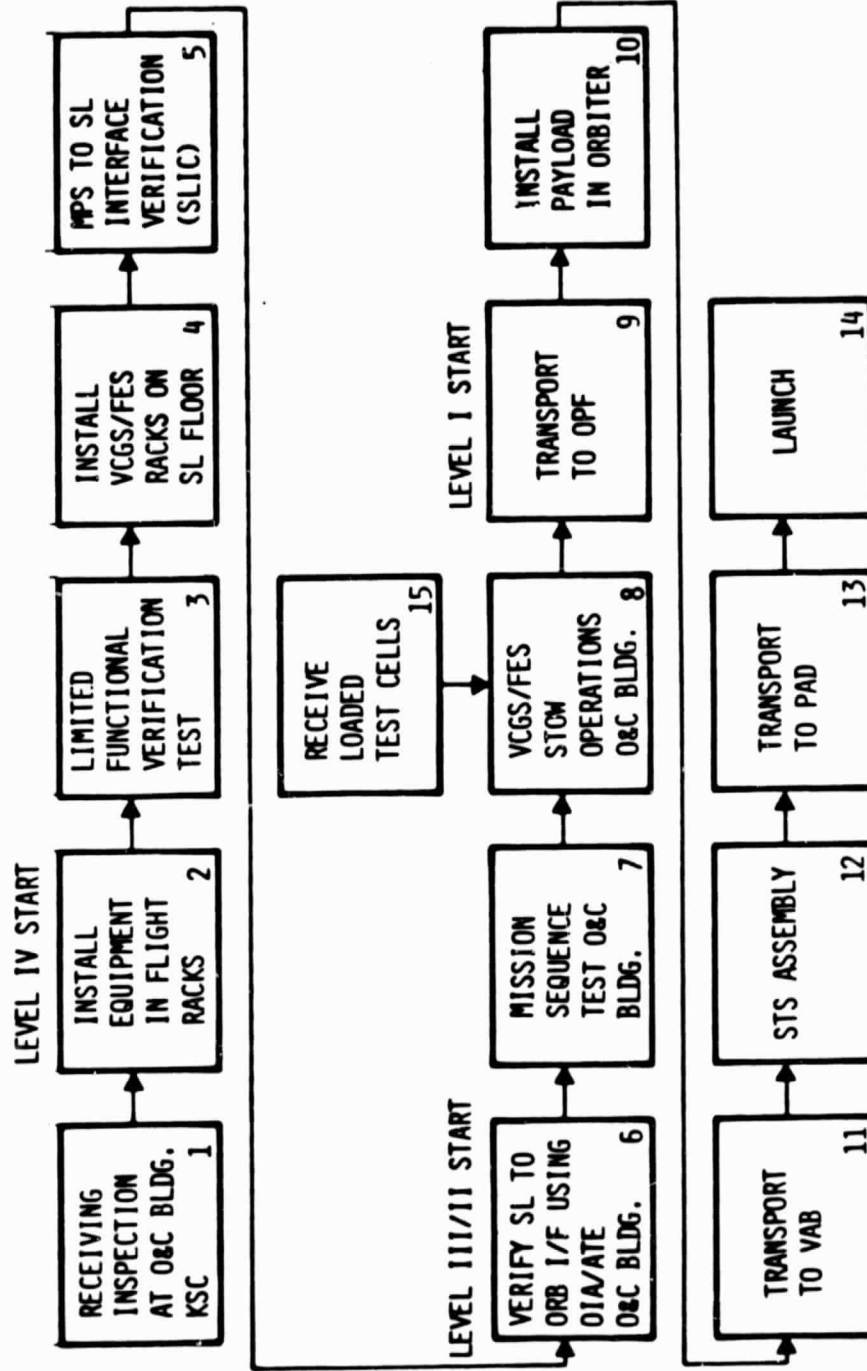
SYSTEM QUALIFICATION/ACCEPTANCE
(319810)

UNIT	TEST
<ul style="list-style-type: none"> ● FES EXPERIMENT WITHIN TEST DOUBLE RACK ● VCGS EXPERIMENT WITHIN TEST SINGLE RACK 	<ul style="list-style-type: none"> ● SYSTEM FUNCTION ● EMI/EMC ● SYSTEM FUNCTIONAL ● ACOUSTIC ENVIRONMENT ● SYSTEM FUNCTIONAL ● ACCEPTANCE FUNCTIONAL



LEVEL IV/III/II/I INTEGRATION

(319810)



TRW/ASPO

SYSTEM LEVEL SYNOPSIS

- MASS AND CG
- POWER
- THERMAL
- ICD STATUS
- OPERATIONS PLANNING STATUS



SYSTEM MASS AND CG STATUS

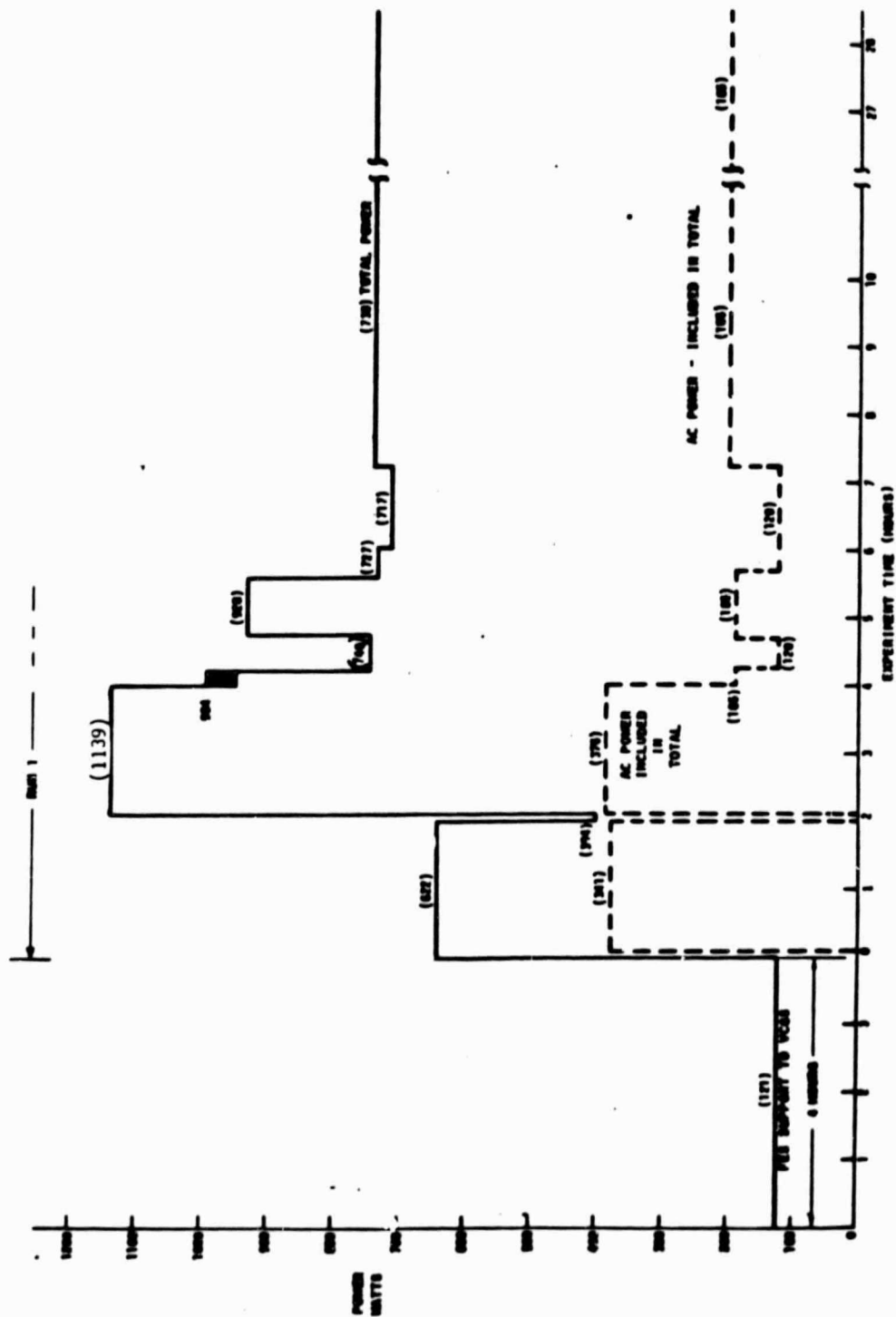
(319340)

RACK	MASS (KG)		CG (MM)						
	DESIGN	ALLOWABLE (SPAH)	DESIGN				ALLOWABLE (SPAH)		
			X	Y	Z	X	Y	Z	
FES									
	UPPER LEFT RACK	70.7	+25 of 72.5	208	399	+51 of 72.5	99/282	246/566	
	UPPER RIGHT RACK	41.2	-15 of 72.5	231	561	+51 of 72.5	99/282	246/566	
	LOWER	334.3	518	361	1092	475/507	99/381	549/1100	
	TOTAL	446.2	--	--	--	--	--	--	
VCGS									
	UPPER	64.4	-8 of 72.5	246	389	+51 of 72.5	99/282	246/566	
	LOWER	87.7	299	320	960	231/333	99/381	549/1100	
	TOTAL	152.1	--	--	--	--	--	--	
STOWAGE									
	TOTAL	79	TEST CELL = 49.9 KG STORAGE ENCL = 11.0 KG FILM = 17.5 KG MISC. = 0.7 KG						

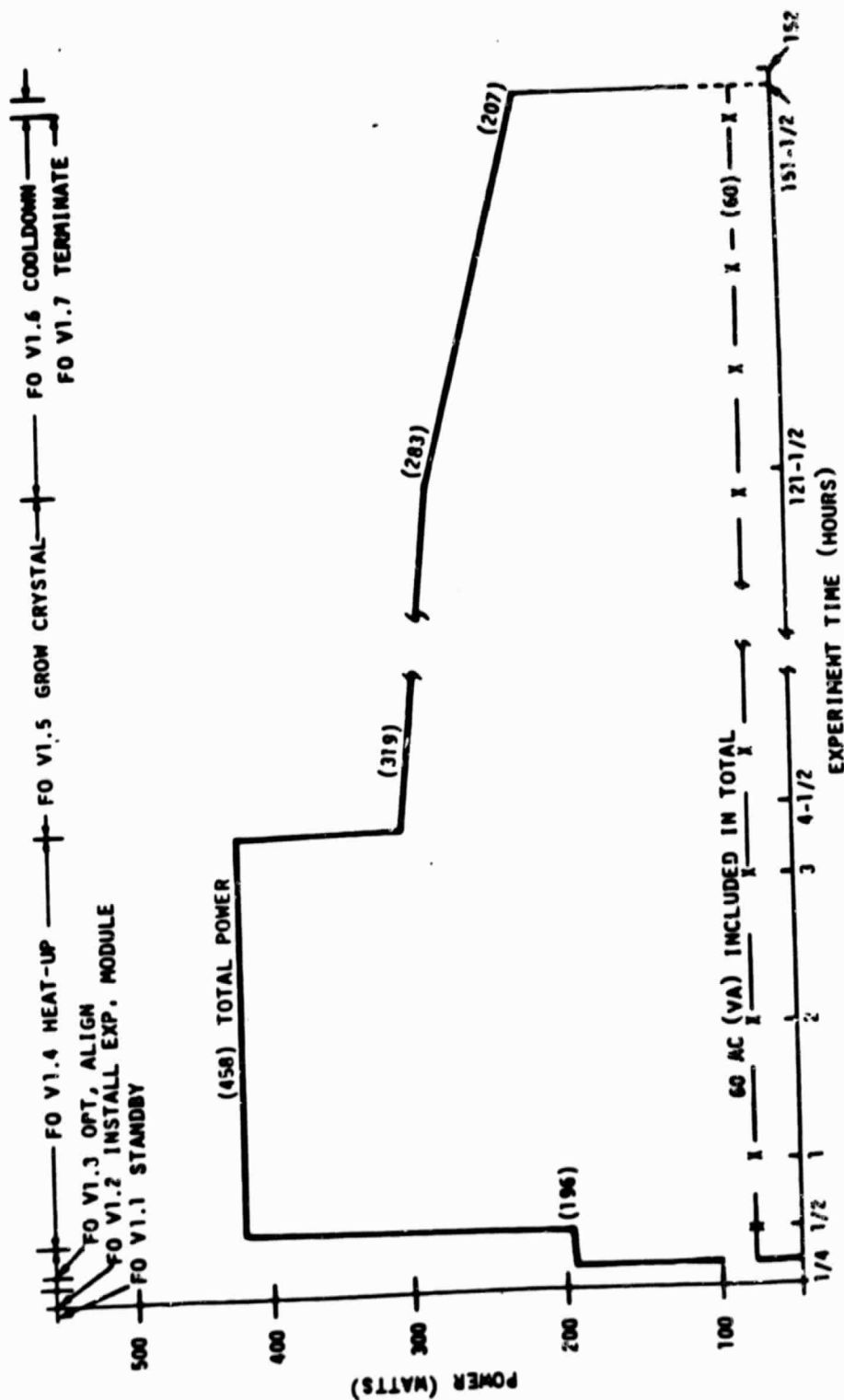


TRW/ASPO

FES POWER PROFILE (RUN 1) (319340)



VCGS POWER PROFILE (319340)



TRW/ASPO

SYSTEM POWER STATUS

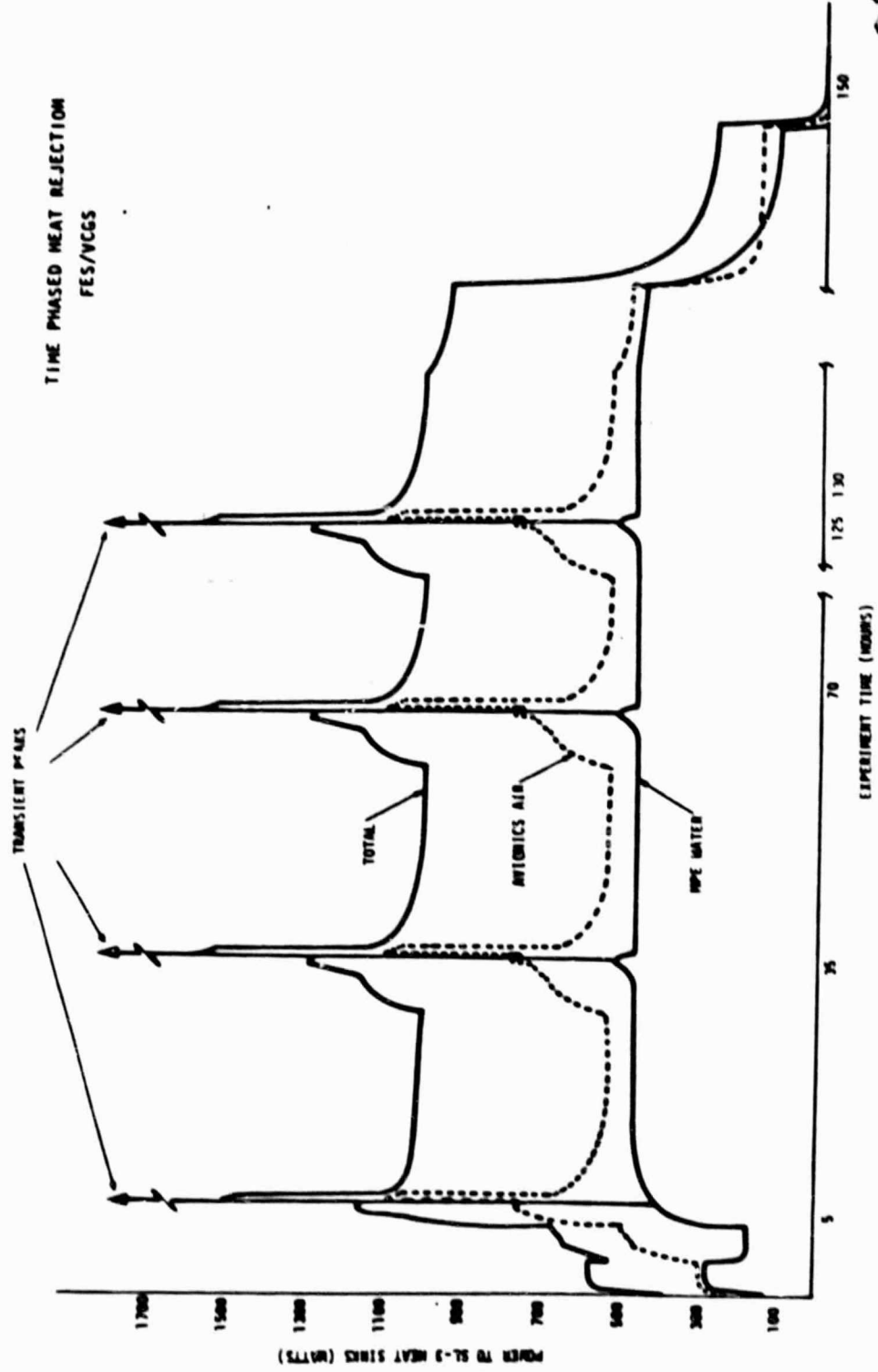
(319340)

EXPERIMENT	DESIGN (WATTS)	ALLOWABLE (WATTS) CEI SY16-9A SY16-18D
<u>FES</u> ● DC ● AC ● TOTAL	0.894 KW PEAK	—
	0.637 KW AVERAGE	—
	0.376 VA PEAK	—
	0.376 VA AVERAGE	—
	1.139 KW PEAK	1.0 KW AVERAGE
	0.834 KW AVERAGE	1.0 KW AVERAGE
<u>VCGS</u> ● DC ● AC ● TOTAL	0.398 KW PEAK	0.500 KW AVERAGE
	0.249 KW AVERAGE	0.750 KW PEAK
	0.060 VA PEAK	0.150 VA AVERAGE
	0.060 VA AVERAGE	0.300 VA PEAK
	0.309 KW AVERAGE	0.750 KW AVERAGE
	0.866 KW AVERAGE	1.750 KW AVERAGE
<u>MPS</u> ● TOTAL DC ● TOTAL AC ● TOTAL	0.866 KW AVERAGE	—
	0.257 VA AVERAGE	—
	1.143 KW AVERAGE	1.750 KW AVERAGE



TRW/ASPO

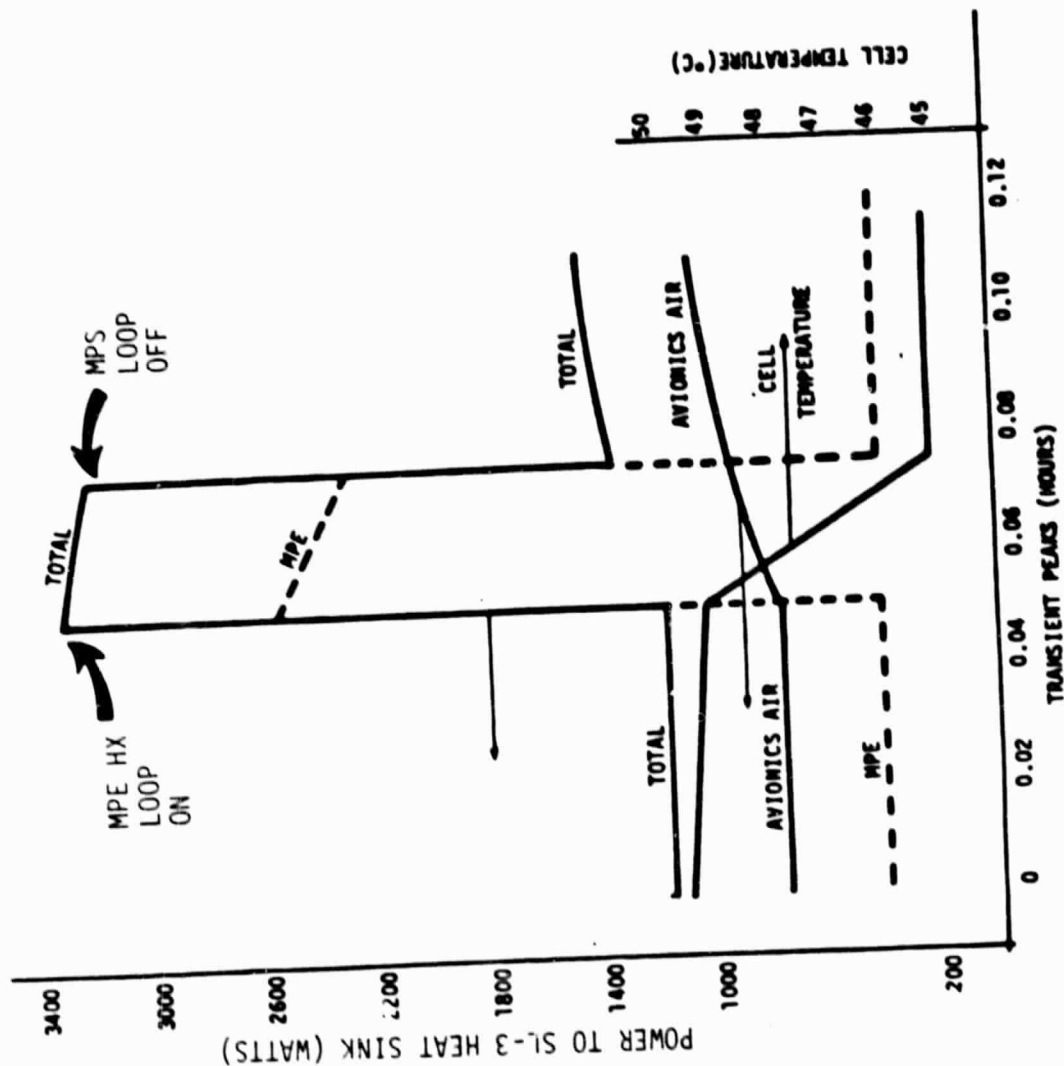
FES/VCGS THERMAL TIMELINE (319340)



TRW/ASPO

FES/VCGS THERMAL TRANSIENT PEAKS

(319340)



TRW/ASPO

SYSTEM THERMAL STATUS

(319340)

EXPERIMENT	AVIONICS AIR		MPE WATER	
	DESIGN	ALLOWABLE 11A, FEB 1980	DESIGN	ALLOWABLE 11A, FEB 1980
<u>FES</u> • FLOW RATE • PRESSURE DROP	21.8 KG/HR/100W 3.6 MBAR	21.8 KG/HR/100W 3.85 MBAR	400 KG/HR 700 MBAR	400 KG/HR 700 MBAR
	21.8 KG/HR/100W 3.6 MBAR	21.8 KG/HR/100W 3.85 MBAR	320 KG/HR 700 MBAR	320 KG/HR 700 MBAR
<u>VCGS</u> • FLOW RATE • PRESSURE DROP	21.8 KG/HR/100W 3.6 MBAR	21.8 KG/HR/100W 3.85 MBAR	400 KG/HR 700 MBAR	400 KG/HR 700 MBAR
	21.8 KG/HR/100W 3.6 MBAR	21.8 KG/HR/100W 3.85 MBAR	320 KG/HR 700 MBAR	320 KG/HR 700 MBAR



TRW/ASPO

SYSTEM INTERFACE STATUS
(SL-3-CDR-34)

- BOTH INTERFACE CONTROL DOCUMENTS IN CDR DATA PACKAGE
- FES/VCGS MECHANICAL ICD-A
 - DOCUMENT IF3-1096
- FES/VCGS ELECTRICAL ICD-A
 - DOCUMENT IF3-1097



OPERATIONS PLANNING STATUS

- INTEGRATION DESIGN DETAILS
- INTEGRATION OPERATIONS PLANNING



OPERATIONS PLANNING STATUS

- INTEGRATION DESIGN DETAILS
 - GOOD COORDINATION WITH SL-3 MISSION OFFICE
 - NO INTERFACE PROBLEMS IDENTIFIED
 - CHECKING LATEST FLIGHT RACK DRAWINGS FOR DESIGN COMPATIBILITY
- INTEGRATION OPERATIONS
 - NO CHANGES OR EXPANSION IN PRR/PDR PLANNING DETAILS DUE TO SL-3 DELAYED LAUNCH DATE
 - EXPECT EXPANSION ~18 MONTHS PRIOR TO LAUNCH



FES/VCGS GROUND SUPPORT EQUIPMENT

CDR OVERVIEW



MECHANICAL GROUND SUPPORT EQUIPMENT

<u>UNIT</u>	<u>FUNCTION</u>
AIR COOLING UNIT	SIMULATED S/L AVIONIC AIR INTERFACE
WATER COOLING UNIT	SIMULATED MPE COOLANT LOOP INTERFACE
THERMAL CONTROL DRYING UNIT	PURGE AND DRY FES/VCGS FLUID LINES
FES/VCGS SHIPPING CONTAINER (1 EACH)	SHIP AND STORE ASSEMBLED RACKS
RACK ROTATION FIXTURE	HANDLING AND ROTATING ASSEMBLED RACK
SLING SET	LIFTING OF RACKS AND INSTALLATION FIXTURE
EXPERIMENT ENCLOSURE INSTALLATION FIXTURE	HANDLING AND POSITIONING OF EXP. ENCL.
TEST CELL INSTALLATION FIXTURE	HANDLING AND POSITIONING OF TEST CELL
FES/VCGS SUPPORT DOLLY (1 EACH) (NASA DESIGN)	SUPPORT AND MOVEMENT OF RACKS
FLIGHT EQUIPMENT SHIPPING CONTAINER	SHIP AND STORE FES TEST CELL, VCGS EXP. MODULE AND MISC. FLIGHT EQUIPMENT
FES/VCGS PROTECTIVE COVER SETS	CONTAMINATION AND CONTACT PROTECTION



ELECTRICAL GROUND SUPPORT EQUIPMENT

UNIT	FUNCTION
* DATA CONSOLE SUBSET DATA CONSOLE KEYBOARD AND CIRCUIT HIGH SPEED PRINTER RECORDER	DECOMMUTATION AND PROGRAMMED DISPLAY OF ALL FES/VCGS DOWNLINKED DATA IN ENGINEERING UNITS WITH LIMIT CHECKING
* POWER CONSOLE SUBSET POWER CONSOLE EPSP SIMULATORS	PROVIDE AC AND DC POWER WITH SPAH 2104 REGULATION AND POWER MONITORING AT THE LOAD INTERFACE

* SHARED WITH SES



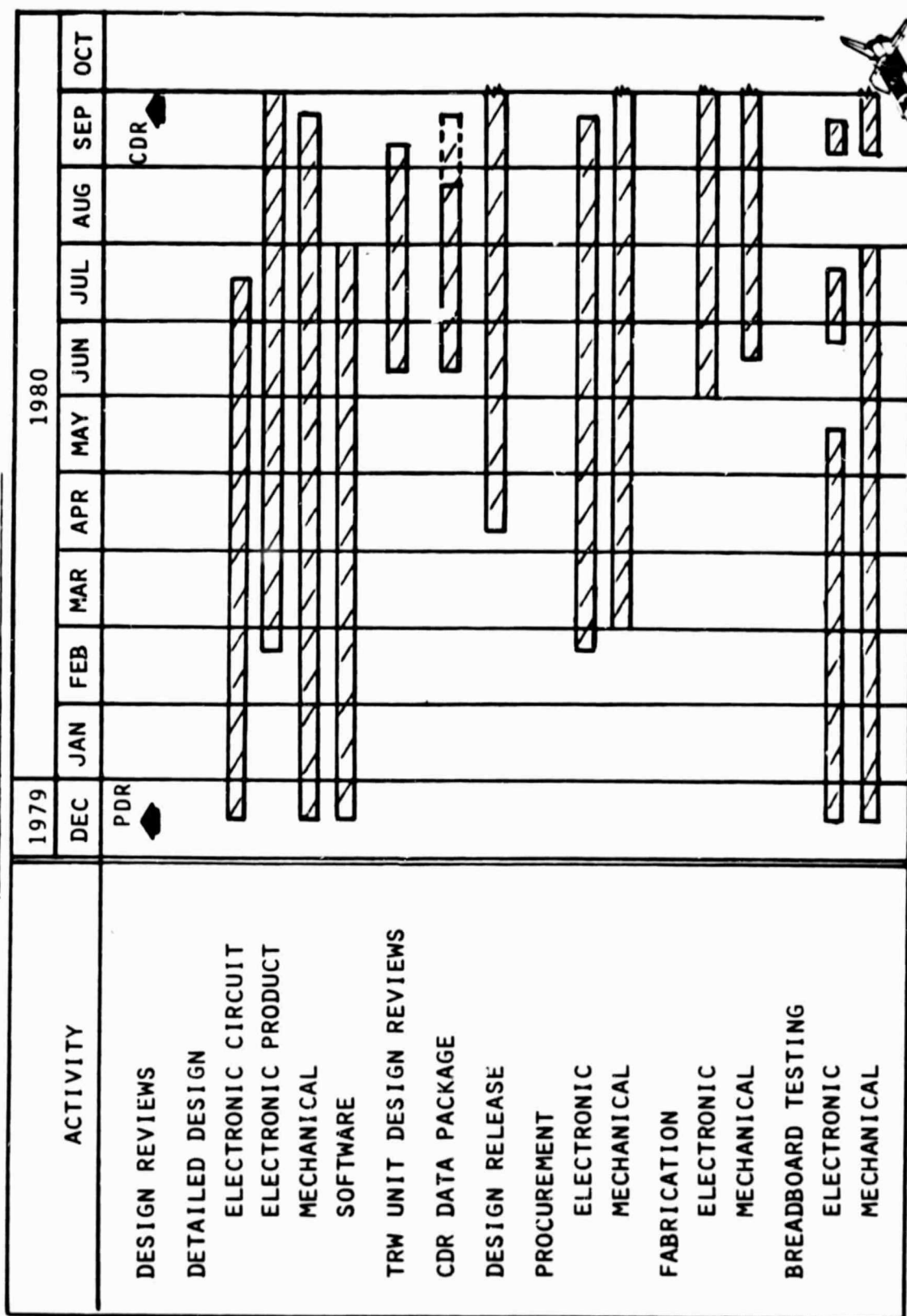
TRW/ASPO

CDR STATUS SUMMARY

- DESIGN
- PROCUREMENT
- FAB AND ASSEMBLY
- VERIFICATION
- REQUIREMENTS COMPLIANCE
- CDR REVIEW



POST-PDR ACTIVITIES SCHEDULE



POST-CDR ACTIVITIES SCHEDULE

ACTIVITY	1980								1981							
	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
CDR																
DESIGN RELEASE																
PRCUREMENT																
FAB AND ASSEMBLY																
BREADBOARD TESTS																
DEVELOPMENT TESTS																
UNIT QUAL TESTS																
SYSTEM QUAL/ACCEPTANCE DELIVERY																



DETAILED DESIGN STATUS

- ELECTRONICS HARDWARE
 - ALL CIRCUIT DESIGNS COMPLETED
 - ALL PACKAGING DESIGN COMPLETED - UNIT LEVEL ASSEMBLY DRAWINGS IN FINAL STAGES
 - ~ 98% RELEASED
- MECHANICAL HARDWARE
 - ALL MECHANICAL DESIGNS COMPLETED
 - ~ 90% RELEASED
- SOFTWARE
 - OPERATING SYSTEM COMPLETED
 - APPLICATIONS TASKS COMPLETED
 - SOME REPEAT FUNCTIONS BEING ADDED
- UNIT DESIGN REVIEWS
 - ALL UNIT DESIGN REVIEWS COMPLETED



TRW/ASPO

PROCUREMENT, FAB AND VERIFICATION STATUS

● PROCUREMENT

- ELECTRONIC PARTS - ~100% PROCURED
~ 70% RECEIVED
- MECHANICAL UNITS - ~ 40% PROCURED
< 5% RECEIVED

● FABRICATION AND ASSEMBLY

- ALL MULTILAYER CIRCUIT BOARDS COMPLETED
- KITS FOR BOARD STUFFING BEING ASSEMBLED
- KITS FOR UNIT INTERCONNECT HARNESES BEING ASSEMBLED
- MECHANICAL ASSEMBLIES BEING RELEASED FOR OV FAB
- SMALL MECHANICAL COMPONENTS BEING BUILT IN-HOUSE SHOP

● VERIFICATION

- BREADBOARD TESTING ~98% COMPLETE
- DEVELOPMENT TEST PLAN COMPLETED
- UNIT QUAL TEST PLAN COMPLETED
- SYSTEM VERIFICATION PLAN UPDATED



DESIGN REQUIREMENTS COMPLIANCE

- ALL DESIGN REQUIREMENTS ARE MET EXCEPT FOR SEVEN REQUESTED WAIVERS
- NINE ADDITIONAL CEI SPECIFICATION CHANGES REQUESTED
 - TWO FES
 - SEVEN VCGS



SYSTEM WAIVERS REQUESTED
(SL-3-CDR-20)

NO.	UNIT	REQUIREMENT	WAIVER	REASON
001	TV MONITOR	CONDUCTED SUSCEPT. 1.5V RMS RADIATED SUSCEPT. 3.5V/METER VOLTAGE 28+4,-5	0.64V RMS 1V/METER 28 + 4 VOLTS	USE EXISTING OFF-SHELF MONITOR
002	PCDA AND ACCELEROMETER	DC ISOLATION 1 MEGOHM (DC-25Hz)	500 OHMS PCDA 3000 OHMS ACCEL. AT 25Hz	USE EXISTING FLIGHT QUALIFIED UNITS
003	GROUND TEST SOFTWARE (VCGS)	DISPLAY 1 SAMPLE PER SECOND	DISPLAY 1 SAMPLE PER 10 SECONDS	USE EXISTING PROJECT EQUIPMENT
004	GROUND TEST SOFTWARE (FES)	DISPLAY 1 SAMPLE PER SECOND	DISPLAY 1 SAMPLE PER 10 SECONDS	USE EXISTING PROJECT EQUIPMENT



SYSTEM REQUESTED WAIVERS - (CONT'D)

NO.	UNIT	REQUIREMENT	WAIVER	REASON
005	PCDA	ACCEL. ENVIRONMENT RADIATION ENVIRON. PM&P SHIPMENT	PER FMDM SPECIFICATION	USE EXISTING SHUTTLE QUALIFIED UNIT
006	KNIFE-EDGE STEPPER MOTORS	2.5 MILLIOHM BONDING	0.1 OHM BONDING VIA WIRE FROM MOTOR	PHYSICAL CONSTRUCTION OF ASSEMBLY PREVENTS OTHER BONDING METHODS
007	FUSES	HOT LINE FUSES BLOW BEFORE UPSTREAM EPDS BREAKER TRIPS	USE MIL SPEC 15 AMP FUSES. 300% BLOW-TIME EXCEEDS SPAH ALLOWABLE	UNABLE TO FIND SPACE-QUALIFIED 15 AMP FUSES THAT MEET SPAH REQUIRE- MENT UNAMBIGUOUSLY



TRW/ASPO

REQUESTED FES SPECIFICATION CHANGES

SYSTEM	PRESENT REQUIREMENT	REQUESTED CHANGE	REASON
<ul style="list-style-type: none"> CELL 	<ul style="list-style-type: none"> FLUID SENSOR LOCATION 2.5CM CELL CENTER-LINE 	<ul style="list-style-type: none"> 2.7CM FROM CELL CENTERLINE 	<ul style="list-style-type: none"> PHYSICAL CONSTRAINTS OF CELL CONSTRUCTION
<ul style="list-style-type: none"> EXPERIMENT ENCLOSURE 	<ul style="list-style-type: none"> SEALED ENCLOSURES LEAKAGE 0.5CCM AT 7 MILLIBARS 	<ul style="list-style-type: none"> DELETE REQUIREMENT 	<ul style="list-style-type: none"> CANNOT SUBSTANTIATE REQUIREMENT



TRW/ASPO

REQUESTED VCGS SPECIFICATION CHANGES

SYSTEM	PRESENT REQUIREMENT	REQUESTED CHANGE	REASON
● EXPERIMENT ENCLOSURE	● SEALED EXPERIMENT ENCLOSURE	● LEAKAGE CONSISTENT WITH SAFETY REQUIREMENT	● LEAKAGE MEETS SAFETY REQUIREMENTS
● AIR LOOPS	● ISOLATE CABIN AIR FROM RACK AND VCGS AIR LOOP	● DELETE	● NO RACK ISOLATION REQUIREMENT AND CLOSED LOOP MEETS SAFETY REQUIREMENTS
● LIGHTING	● NO DETECTABLE IR <3500 ANG.	● <10 WATTS/CM ² FOR <3500 ANG.	● HARDWARE CAPABILITY
● TEMP CONTROL.	● PERIOD ACCURACY TO ±2.5%	● 2.5% ≥ 40SEC 1 SEC FOR <40SEC	● CONTROLS COMPLEXITY
● TEMP CONTROL	● TIME AND TEMP LIMIT APPLY	● ONLY TIME GOVERNS	● PROVIDE CONTROL MODE DESIRED
● TEMP CONTROL	● STABILIZATION PERIOD	● NO STABILIZATION PERIOD	● PI REQUEST



TRW/ASPO

CDR REVIEW STATUS

- DETAILED TEAM REVIEWS
 - SYSTEMS ENGINEERING/INTEGRATION/INTERFACES/OPERATIONS
 - MECHANICAL DESIGN AND DEVELOPMENT
 - ELECTRICAL DESIGN AND DEVELOPMENT
 - ASSEMBLY AND VERIFICATION
 - SOFTWARE
 - SCIENCE
- RID STATUS

